RAILROAD GAZETTE

SATURDAY, APRIL 13, 1872.

The St. Joseph Bridge.

Below is the report of Col. E. D. Mason, Chief Engineer of the St. Joseph Bridge Company, which is dated February 13, 1872, and directed to Hon. Willard P. Hall, President of the company:

SIR: I have respectfully to make the following report to you regarding the present condition of the work undertaken by the St. Joseph Bridge Building Company:

Before doing so, however, it may be interesting to recall a few of the dates at which some of the more prominent portions of the work were begun, and which may serve as guides to indicate the progress made.

On the 1st of February of last year, upon your commission so to do, an engineering corps was organized and a preliminary survey begun. On the 15th of March following, the first report was made, and approximate estimates for a bridge and shore protections were submitted by me for your consideration.

Directions to prepare plans and specifications for the bridge were received about the 20th of March. An invitation for bids upon the work according to the plans presented, was first published the 4th of May, and the time for receiving them extended to the 10th of June.

On that day the contract was awarded to the Detroit Bridge and Iron Works, and steps were immediately taken to begin the work.

In order to sink the caissons for the piers to the rock by the system adopted (the pneumatic), a large amount of heavy and costly machinery was necessary, and considerable time passed before it could be got together and set up ready for use; and this time was employed by the contractor in accumulating material and perfecting his arrangements.

The machinery was first started at work sinking the west abutment, known as Pier VI., on the 9th of November, and the caisson was safely landed on the rock the 7th of December. Pier V., the next piece of masonry east, touched rock the 31st of January last. The exceeding coldness of the season greatly hindered the work on both piers.

Work was begun on the breakwaters and shore protections between the bridge location and the point of land northeast of Elwood, on the 27th of September. They will be finished the 17th inst.

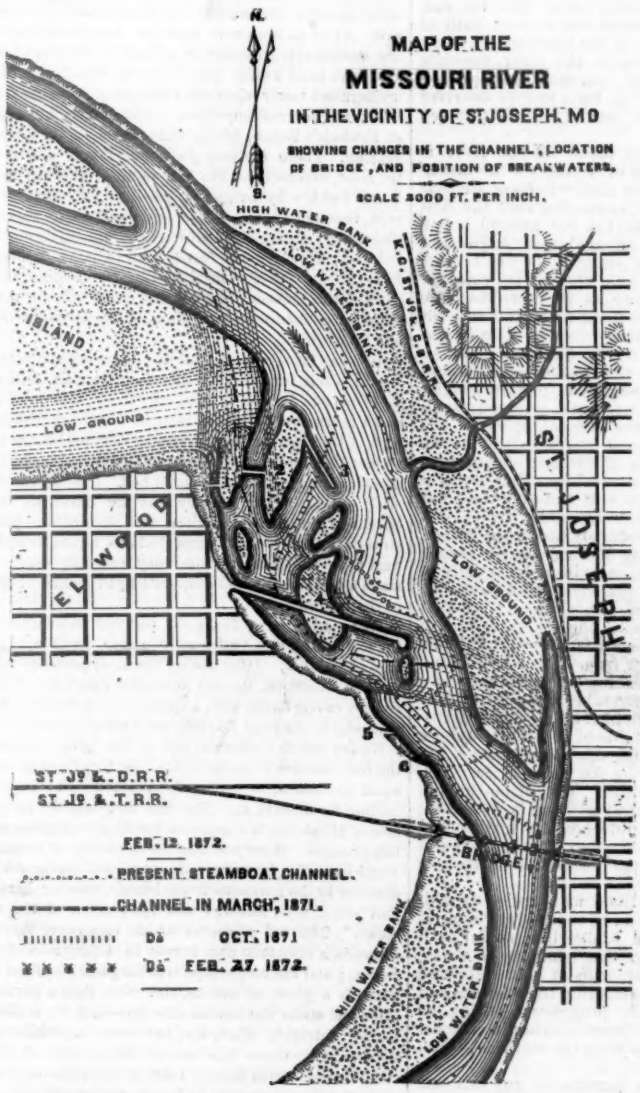
The condition of the work at this date is as follows:

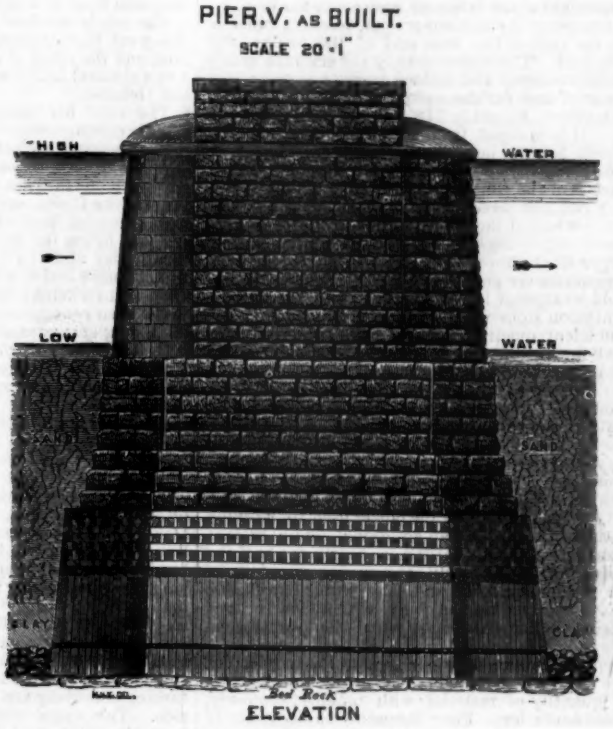
The west abutment is finished. Its foundation is hard limestone rock, 61 feet 3 inches below high water.

Pier V. is landed on the same stratum of rock that supports the west abutment, and its foundation is 64 feet 2 inches below high water. All work except pointing the joints is finished below medium high water, and seven days' work with a gang of masons will complete the pier.*

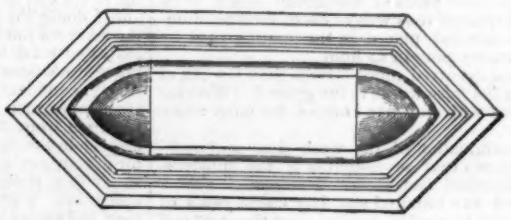
In sinking Pier V. and the west abutment, strata of

* March 5, 1872.—This pier is now finished.

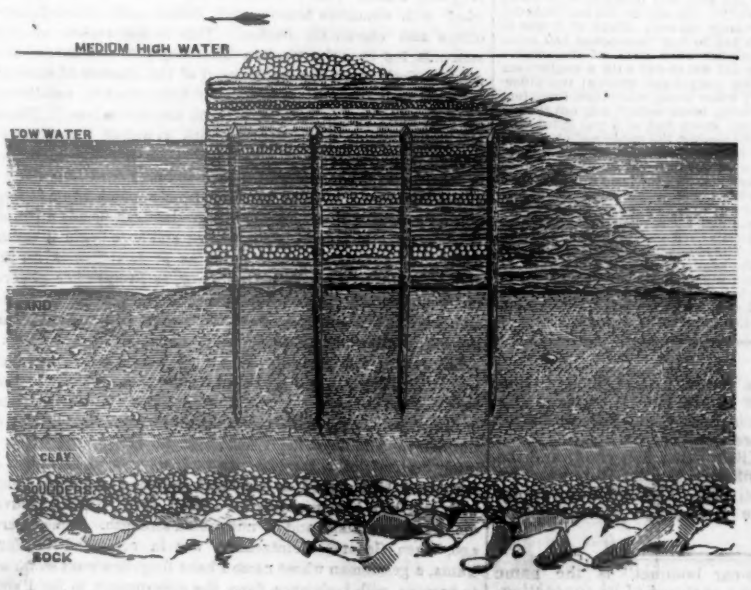




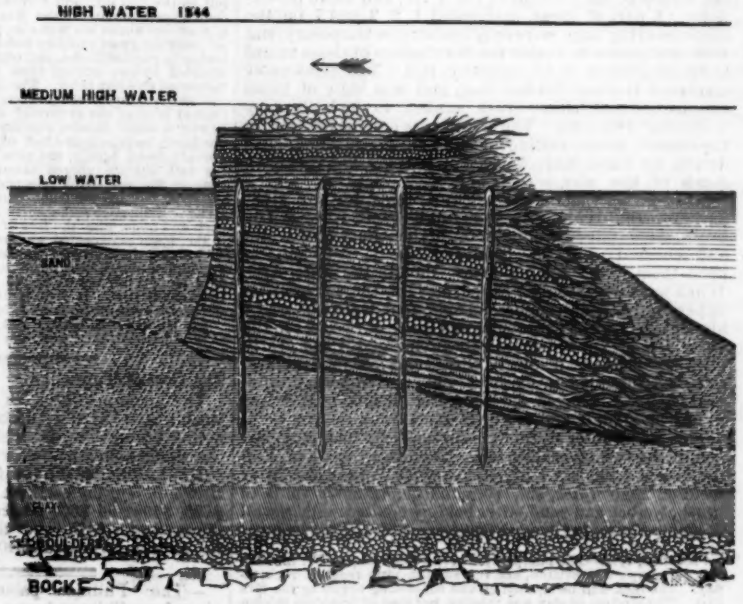
ELEVATION



PLAN.



Breakwater Four as Designed.



Breakwater Four as Built in the Channels.

sand, coarse and fine, were passed through for 30 feet, then stiff blue clay five feet, and lastly, a deposit of coarse gravel and bowlders, through which flows a stream of water of mean temperature, and entirely separate from that in the river.

The caisson for Pier IV. is finished and lowered from the ways upon which it was built to the sand bed of the river, five feet below the surface of the water. The machinery for sinking it is set up and connected with the engines; the steam derricks with which to lay the masonry at the proper time are ready, and to-morrow the sand pumps will begin work.†

Enough timber is on hand to build the caissons for Piers II. and III. and the draw-rests. The iron trusses with which to suspend the caissons for Pier II. and the draw-rests while building, are well under way at the contractor's shops, and the setting up of the caisson for the upper draw-rest and ice-breaker will begin as soon as the ice breaks up in the river. A large quantity of plank for the draw-rests is delivered, and three-fifths of the riprap for them is piled on the bank at the east end of the bridge The caisson for the upper draw-rest is 40 feet wide by 60 feet long, and its foundation will be about 68 feet below high water.

Of the dimension and backing stones to be used in the work, seven-eighths are delivered, and seven-tenths of the quantity necessary to complete are cut, marked, piled in courses in the yard at the west end of the bridge, and ready to be laid. The stones already cut embrace nearly all the bush-hammered and molded work.

The material used for the masonry is a beautiful "magnesian" limestone, weighing 144 pounds per cubic foot when dry. It is brought from "White's Quarries," on Spring Creek, Kansas, near the line of the St. Joseph & Denver Railroad, 108 miles west of the Missouri River. The thickness of the courses varies from twenty inches to three feet; two feet three inches being about the average.

The severest test of the ability of this stone to endure frost without injury has been afforded this winter. Nearly all the larger blocks, those from which the bridge-seats and string-courses are cut, were quarried during the excessive cold weather of last November; and the quarrying of dimension stone was not stopped until in January, when a sufficient quantity for the work was ready for transportation; but not one stone of the stratum used has been split or checked by frost either at the quarry or in the yard. The large quarries on the Mississippi River and in Northern Illinois are usually closed about the first of November, and even then sometimes a large percentage of the last stones taken out are shattered by freezing before they can "season" properly.

The contractor is well supplied with first-class workmen, machinery, engines, tools and boats. Within the past month he has duplicated the power used for working the sand pumps, and put up an additional pump, so that we are now able to sink a caisson in nearly one-half the time required for those already sunken.

All the machinery, tools and false works applicable thereto, have been set up and built with a view to their use in raising the superstructure when the proper time arrives.

The arrangements in the stone yard at the west end of the bridge are the best I have ever known for handling the same quantity of material with rapidity, economy, and without confusion. Four thousand cubic yards of cut stone were at one time so stored and marked that any particular course could be removed without disturbing another; and 70 cubic yards of dimension stone, averaging one and a quarter tons weight each, have been unloaded from the cars and placed in the cutting yard by the ordinary working gang in an hour.

No casualty has occurred more serious than the fall of a workman from the false works to the ground, a distance of twenty feet, by which he was unfitted for labor about ten days.

A thorough examination of the work done and materials furnished shows that seven-tenths of the substructure is an accomplished fact.

Seven thousand two hundred and fifty cubic yards of riprap, all that will be needed, is piled near the west end of the bridge, ready to be used for facing and protecting the banks of the approaches. It is purposed not to build these banks until after the subsidence of the spring floods.

Seven pieces of work are built to act as breakwaters, controllers of the current in the river, and shore protections. A part of these, designated 1, 2, 3 and 7, on the accompanying map, were only intended as temporary, and were built more to enable the foundations of those meant to be permanent to be properly laid. The breakwater marked 3 is about 800 feet long, and was built of small cottonwood and willow brush sunken to the bottom by weighting with sand. The brush were kept in position in the current, before resting on the bottom, by small piles driven by hand with a wooden maul. The channel, much of the way across, was from eight to eleven feet deep, with a current swifter than in any other part of the river for two miles each way. The brush were piled about a foot higher than low water and covered with a layer of sand sufficient to keep them from floating away should the water rise. When work was stopped the surface of the water at its upper end was, on the channel side, four-tenths of a foot higher than on the shore side; and a rise of two feet in the latter part of November entirely submerged it and nearly filled the channel below it with sand. This structure, although intended to exercise only a temporary influence, entirely changed the low water channel of the river in ten days' time, and it still remains complete.

The breakwater running southeasterly from the east end of the "Wathena McAdamized Road," marked 4 on the map is 2,100 feet long, 60 feet wide at the base, 30 at medium high water, and contains 56,000 cubic yards of brush, timber and sand, after being weighted with a wall of riprap averaging twelve feet wide and three feet high.

† March 5, 1872.—The pumps were set at work on pier IV. the day this paragraph was written, and the suction pipe reached rock today. The rock will be cleaned off and concreting begun by the 10th inst. The stratum of clay was thinner, but that of bowlders thicker than at Pier V., and the surface of the rock is 65 feet 6 inches below high water. The masonry is built to within six feet of high water.

At the point where the work was begun the river hugged the Kansas shore and was rapidly cutting away the land. The channel, at low water, was 500 feet wide and 20 feet deep, and the velocity of the current was four miles per hour. The brush and timber were kept in position, until sunken to the bottom, by piles about ten feet apart, well driven with a steam pile-driver. More than 700 piles were used in building the foundations. When the work had progressed so as to materially contract the channel the current scoured the bottom until a depth of 26 feet was reached. At this time the temporary work, 3, already described, was designed and built for the purpose of turning the current away from the larger work, or at least of materially reducing its volume. The success of the plan equaled our most sanguine expectations, and the main body of the river formed a channel a thousand feet to the east of its old bed. The bottom of this old bed was now but five feet above a stratum of stiff clay, and but fifteen feet above the rock: and the breakwater was built across it before time was given for it to fill with sand and mud deposits.

The second channel, when crossed, was wider and the current swifter, but with an average depth of only ten feet. A bar about two feet under water, near the east shore of this channel, was reached, and a mole built of the same kind of materials used in the breakwater.

The whole width of water way in the river opposite this work is, at its present height, less than five hundred feet, and the effect of the work has been to give the river a new channel half a mile east of that in which it flowed last October.

The sand bar along the east shore of the river is rapidly cutting away. The wall of riprap on the breakwater is about two feet above the higher parts of the bar opposite its easterly end, and it is expected that the first flood will cut through the bar at the low ground below Blacksnake Creek, and find its channel in the bayou and along the high bank of the east shore to a point some distance below the bridge. The old channel between the breakwater and the Kansas shore, as far down as shore protections 5 and 6, will soon be filled with sand and silt deposits to a height above ordinary floods. The breakwater is so constructed that it may be undermined by an impinging current until it shall sink to the bed-rock and still leave the riprap wall at nearly its present height. The current in the river can never have a velocity sufficient to carry it away while the present space is left between its east end and the east shore, except in the event of a cut-off along the foot of the east bluffs immediately above the city; and I am confident that, even in that case, it would direct the current and save the point of land on the Kansas shore below Elwood.

The "shore protection" immediately above the bridge, on the Kansas side, commonly known as "Weaver's Dyke," marked 6 on the map, is built substantially of like materials and in the same manner as breakwater 4; but it serves a different purpose. It is about 1,200 feet long, and lies nearly parallel with the general course of the river, crowding the channel gradually toward the east side. It was built in water from 12 to 15 feet deep, but an impinging current working on it during two months has undermined the outer edge and allowed it to sink, in some places to a depth of 25 feet, without disturbing materially the height or line of the inner or shore side. The space between it and the Kansas shore has been filled with sand deposited by the water in the river, so that it is now dry at low water. The distance from the lower end of this work to the east bank is 1,000 feet; and I doubt the economy of building it any further into the channel until a spring flood shall have passed and indicated what is best to be done should more work be thought necessary.*

I am confident that the next flood will furnish us with such experience as will enable us to successfully control the river from Belmont to the bridge line, so far as it may be in the interest of the bridge company to do so, for a sum not exceeding three-fourths of that estimated in my first report to you. Considering the success and speed with which the work has progressed during the long and severe winter we have been laboring in, I know of nothing in the way of completing the work as at first contemplated.

I see nothing to suggest an increase of any estimate made in my preliminary report.

* March 5, 1872.—Breakwater 4 was finished, and the riprap all put on the 16th ult., and "Weaver's Dyke" the day after. The ice commenced moving in the river the 21st, and broke up with a rise of nine feet above low water on the 23d. During the 23d and 24th, the ice ran with great rapidity and in large masses. Much of it was 16 inches in one thickness, and often two to four thicknesses had accumulated by one sliding upon another until some of the masses measured five feet thick. The ice did not go out with a continuous and uniform flow, but by successive gorges and breaks; the difference of level of the surface of the water being sometimes three feet in half a mile. During the break-up, breakwater 4 did not change position; but about 200 feet of the lower end of 3 was lifted and brought down bodily, and now lies against the upper end of 4. On the 24th the ice gorged about 300 feet below the end of 4, first against the east bank, the gorge extending westerly nearly across the river, causing the whole current to strike the head of "Weaver's Dyke" with such force as in a few hours to cut a channel 34 feet deep and undermine the face of the dyke. The dyke "turned over" in the manner expected, and remained a complete breakwater, so far proving the ability of the materials used and the plan adopted to accomplish the desired purpose. The channel opposite the east end of 4 is now 660 feet wide, and the whole bar below the mouth of Blacksnake Creek is rapidly becoming narrower by the washing of the current directed toward it by breakwater 4.

The ice was hard enough and flowed with such force as to saw off, at the surface of the water, elm piles 16 inches in diameter.

The Cost of Tunneling.

The London *Times*, in a recent article, gives a tabulated statement of a number of the more important tunneling enterprises, in which the cost per linear yard of the works below named were as given:

Mont Cenis, $975; the Kilsby, the Saltwood, and the Bletchingley, the costliest of the English tunnels, cost $725, $590 and $360 respectively. That of Terre Noire (France) cost $475, and the Hoosac, in Massachusetts, has thus far averaged $940.

—The "Pullman palace-car bouquet" is the name given by a Chicago house to a perfume of its concocting. It is a good name for something extraordinarily fine.

Contributions.

THE SOUTHERN ROUTE TO THE PACIFIC.

NUMBER SEVEN.

San Francisco, March 27, 1872.

What the Mississippi is to the Atlantic slope the Rio Colorado is to the Pacific, in some degree. At Fort Yuma it is not over half as wide, and carries less than half the body of water that its great congener does; but what it lacks in dimensions it amply makes up in truculence and treachery. Below the fort the banks are very low, almost as low as those of the extreme lower Mississippi, and the Colorado plows them up, shifts, recasts and sweeps them away with so much mobility that the channel is even more changeable than in the middle Mississippi or Red River. Six or seven feet is about all the steamboat pilots can depend on over the bars, and grounding is more frequent than on Red River even. So uncertain is the tenure by which the banks hold that there is no growth of trees, nothing but cottonwood saplings, willows and the densest mesquite brakes I ever saw. As on all the rivers from the Pecos westward, the banks are exceedingly treacherous, perfect cattle-traps; and animals that have lived awhile here learn to dread it, and snort with undisguised terror when one attempts to drive them near it.

There is no grass anywhere in the vicinity, but I am told that at Frederic's Ranch, fifteen miles below, there was considerable grazing. There are very good margins of alluvial land along the river, especially on the Arizona side; and the Mexicans and Yuma Indians by irrigation produce tolerably good melons, corn, vegetables, etc. There is a stout rib of rock and gravel singularly running right athwart the desert, through which the Colorado rifts a *canon* 50 feet deep and a half-mile long, and which forms on one side a natural breakwater to shield Arizona City against the freshets, and on the other side furnishes a commanding eminence for Fort Yuma. It is a most admirable natural site for a bridge.

Arizona City is as miserable and accursed a hole as any in the world. Consisting of a few naked mud-hovels, called by courtesy stores and dwellings, with only three inches of rain a year, and a thermometer which mounts above blood-heat half the days of the year, and sometimes to 140 deg. in the shade—it is a place that Dante might have studied to advantage before he described the orthodox medieval hell. One of the most melancholy sights of our journey was the bloodless, fever-wasted cheeks of the garrison soldiers, with their prison pallor. Yet—strange to relate—the Yuma Indians are taller and more stalwart than the Pimos, whom they anciently worsted, and they made a most bloody and desperate fight before they submitted to the government.

There are many jokes, good, bad and indifferent, cracked at the expense of this American Avernus. I will only give a bit of true experience. After seeing firewood procured with a crowbar and a mattock, and hay harvested with a hoe, I finished Arizona by eating butter with a spoon, in a hotel kept by a China man who spoke good English and had no pigtail.

We are now in California, and on the great Colorado Desert, the only real desert on the route. So far as it reaches, it is quite equal to Sahara, is eminently satisfactory to anybody who is looking for deserts, and, like the unspeakably ugly, pox-pitted face of Mirabeau, it is glorious for its unmitigated and supreme hideousness. Here you may see anything of scenery that the world can offer, from the half-eaten and blackened corpse of a deserter to the gorgeous tropic islands, moving caravans, phantom ships, seas, icebergs and spiry cities of the "dissolving views." The red simooms which moan over this savage wild sometimes bury men and horses in a fiery rain of sand, as on Sahara; and the only escape is to fling one's self flat on the sand beneath a piece of canvas, and even then a person must rise often and shake the canvas, else he would be suffocated, if not buried outright. Here, too, but more especially in Western Arizona, sometimes falls out of heaven one of those fearful cloud-bursts, which pours a roaring deluge down a dry *arroyo*, sweeping men, animals and houses to destruction.

Colorado Desert is about 115 miles wide, but it laps over the Sierra Nevada 30 or 40 miles further. The first 40 or 50 miles is pure, naked, yellow sand, often ripple-marked by the wind with wondrous beauty and dotted with stunted mesquites and *cheriondia* bushes. This is the region of the simooms, for over the western half they prevail less, and are comparatively harmless on account of the absence of sand or its water-packed condition. But even here men live, and "men have died and worms have eaten them, but not for love." There is a station about every 20 miles, with a well of sweet water, though there are frequent alkali pools along toward the middle of the desert. The reader will bear in mind that the desert slopes downward, so that, starting from a point 12 or 15 feet above the level of the Colorado, one gradually descends until he is below even the bottom of that river; and here begin to occur occasional lagoons of sweet water as at Los Alamos, for instance, about 50 miles from the river, as I remember—where many hundreds of cattle could drink together. These pools and lagoons are chiefly west of the heavy sand belt, and on the edge of the alluvial belt through which courses New River.

The reader will probably smile when I announce my belief that agriculture will one day be prosecuted successfully in the very heart of Colorado Desert. There is a zone of alluvium ten or fifteen miles wide, quite free from sand, trending northward through the middle of the desert; and though now it is absolutely destitute of vegetation, except here and there a bush a few inches high, naked as my hand, yet when you kick it up with your boot-heel you discover a clean, sweet, reddish alluvium, free from alkali and of undoubted strength. Some years ago, when General Heintzelman was in command of Fort Yuma, a gentleman whose name I have forgotten went so far as to propose, with assistance from the government, to level and ditch this zone, and irrigate it from the Colorado or New River

which is the same thing; but abandoned the project for some reason or other. Irrigation can be easily accomplished, on account of the elevation of the Colorado, like the Mississippi at New Orleans.

New River is without a parallel in the world, to my knowledge, having a great river for its source and emptying nowhere. Branching from the Colorado near the Gulf, it slides down northward through the desert, and disappears on a level about 75 feet below the Pacific. It is a mere creek which one can almost leap over in places; the water is perfectly sweet and wholesome, like Mississippi water, though turbid; and along it there is a shallow "swale," a quarter of a mile wide at the emigrant crossing but much wider near its source, dotted with pretty mesquite trees and covered with a thick fleece of grass green throughout the year. As it takes its origin from the unstable Colorado, some seasons the parent stream crams the mouth of the suckling with sand and stops its flow altogether. An old California drover told me that he used to "bunch" his herds on Warner's Ranch, then push them through a secret pass in the Sierra Nevada, forty miles across the desert to New River, down that stream (or up, rather), finding plenty of grass all the way, swim them over the Colorado at Frederic's, and so into Arizona, without the loss of a dozen head where the Texans lose hundreds crossing in the opposite direction without knowing these secrets.

That Colorado Desert was the former basin of the Gulf of California, or at least the seat of ancient cataclysms, is shown by the wreck of the famous "desert-ship" discovered by Col. A. S. Evans; also by the untold myriads of minute periwinkles which whiten hundreds of acres like frost.

From New River we turned northward to Los Angeles, instead of bearing west to San Diego, hence I can only give the general features of the country. Between New River and the Sierra there is an unbroken, easy slope of gravel, which is rain-packed as hard as a rock to a man's tread, but is broken and poached by the trains. On attaining the backbone of the Sierra Nevada—which here is not much above 2,000 feet high—you perceive that it and the coast range interlock in a confused, tumbling system of hills. Though it is a mere herd of blunt, stubby humps which spread out around you, you can easily distinguish the two ranges—the Sierra hills are overlapped by the desert twenty or thirty miles, yet they are savage with chaparral, whitish-grizzly like the Texas mountains and without a single tree; but as you look westward, you see the distant summits are greener, spiked now and then with pale, thin-haired California pines, and on the farthest rim of the horizon, dark-green with the dense, ever-green thickets of the *chanural*. The Sierra is azoic and granitic, hence its part of the summits has a peculiar grinnness, an aspect of hoary and ancient desolation. The coast range is tertiary and cretaceous, and its clean, white boulders stand up most refreshingly bright amid the Alpine greenery. All the thickets of the Sierra are horridly thorny; in the coast range, and in all California proper, there is no thorn, except in the scattered clumps of cactus. Between these ranks of summits long and narrow valleys are swung down like hammocks, quite desert-like at the eastern end, but Italian-like at the other, the matchless and majestic live-oaks answering to the ilex, and the white bowlders in the dense, vivid green of the mountain sides completing the parallel. Then there are huge, umbrageous sycamores, enormous cottonwoods, living springs, and a rich, thick rowen of burr-clover, *alfileria* and bunch-grass, with jimsons and morning-glories interspersed.

The chain of valleys next westward are broader, and consequently more barren and desert-looking in the middle, with the live-oaks only venturing out a few rods or a quarter of a mile from the foot of the mountains, with perhaps a thread of cottonwoods running down the middle along some little stream. But the pasturage is still good and wonderfully tenacious, for the cattle will live here by the hundreds and thousands through two years of drought, as they have done the past two years in an almost miraculous manner.

But these valleys are still rather thin in soil for cultivation, and it is only in the third or fourth tier from the summit, where they begin to grow very deep and narrow, and are moist, that we find little, long fields of corn, irrigated by some brook, with a willow hedge around them, and the corn growing as tall as in Ohio, with two, three, four, five lusty ears to the stalk. Here in these deep valleys—*canons* almost—barely wide enough to turn a six-in-hand in, you find Texans, living in mud huts with shingle roofs, or shells of whipsawed boards with rattling, rumbling floors, always under a mighty live-oak, as in Texas, and always with a bit of corn-field. Some of them also grow tobacco here, which answers very well for cuds, but is nowise adapted for cigar-making.

These *canons* now broaden out to the vast mustard plains which slope away to the ocean, and we are entirely upon the great rich region of semi-tropical California, whose products and possibilities are so immense that I can only outline a few things in a manner totally unsatisfactory to myself.

First, with the exception of grapes, olives and nuts, nothing ever can or ever will be grown here to any purpose except by irrigation, and that largely from artesian wells. In San Diego County there may be rain enough three years out of seven to bring a crop of wheat, but the other years it will come to nothing. Drought, then, and the untold myriads of ground-squirrels with which Southern California is infested, are two deadly enemies which a man must make up his mind to fight from the beginning and to fight all his life, or he would better not go there. If he has the pluck to do that, and to keep cool under their harassments, he will conquer, and he can go there with the assurance of living longer and living happier than anywhere else in the United States.

To get any average statistics of value we must go to Los Angeles County, and in the article of cereals the averages are higher than San Diego could show. In 1870 there were grown in that county 9,000 bushels wheat, or 30 bushels per acre; 291,000 bushels barley, 30 bushels per acre; 479,400 bushels corn, 47 bushels per acre; 81,800 lbs. peanuts, 919 lbs. per acre; 24,000 bushels beans, 20 bushels per acre; 210,400 bushels potatoes, 86 bushels per acre; 8,250 bushels sweet potatoes, 75 bushels per acre; 9,100 bushels onions, 124½ bushels per acre; 7,700 tons hay, 2½ tons per acre; 45,200 lbs. tobacco, 753 lbs. per acre; 1,064,000 gallons wine, 257 gallons per acre; 1,570,000 lbs. wool; 168,000 lbs. honey, etc. This product of wine is not a fair exhibit on account of the great number of young vines not yet in bearing, for the average product of matured vineyards is over 400 gallons per acre.

Arpad Haraszthy, an Hungarian, and probably the highest authority on wines in California, in a series of articles in the *Overland Monthly* on wine-making, estimates as follows the cost of an acre in this State after the seventh year, compared with an acre in France:

One acre land	$50		
Outlay, first year	30		
" second year	10		
" third year	10		
" fourth year	12	Value of crop	$35
" fifth year	15	" "	42
" sixth year	15	" "	49
" seventh year	15	" "	66
Direct outlay	$157	Direct income	$192
Interest at 12 per cent.	99	Interest at 12 per cent.	52
Total outlay	$256	Total income	$244

This shows that the actual cost of an acre of California vineyard, after the seventh year, is only $12, while in France it is, according to M. Guyot, $556, in spite of their cheaper labor and lower interest. The cultivation of a full-bearing acre in California costs less than $15 a year, while in France it costs $35. This difference is accounted for by the fact that the wet season of France keeps the workmen constantly in the vineyard, plucking out weeds. The same eminent authority, by an elaborate computation, shows the net annual income per acre is $45 on an investment of $112 and interest up to the fourth year. The one great advantage of wine-growing over many other pursuits in California is that the vines require no irrigation, the old padres to the contrary notwithstanding, and hillsides are therefore equally available with valleys, and even better, as men are beginning to discover, on account of the superior quality of the wine. In the heavy "adobe" of the valley the juice is often too rank and "earthy."

In Southern California the apple and the peach, except in the mountain valleys, may as well be eliminated from the account, for they are not worth cultivating, compared with some other fruits, and especially with nuts. Pears grow immensely large, but scarcely first-rate. If our countrymen were not so impatient, but could content themselves to sit in the sun and sing old songs, oranges would be the *ne plus ultra* of fruit crops. There are two things which must be observed to insure a crop of oranges. Unlike the vine, they must be irrigated; secondly, they must not be grown on their own stocks, but budded on lemons a couple of feet from the ground, else the ground-squirrels will destroy them utterly. Last winter, for a wonder to the "oldest inhabitant," ponds near Los Angeles froze over, and Mexican graybeards took the first slice of their lives. Yet the oranges were not damaged, while in the damper air of New Orleans such cold would have destroyed them. I have eaten oranges in many markets, from Naples to Los Angeles, and with one exception the latter are the best I have found. In Matamoras, Mexico, they grow sweeter, but fully a third smaller. I will adduce only one instance of their profitableness. State Senator D. B. Wilson has a grove of seven acres, 20 years old, near Los Angeles, from which he is said to derive a revenue of $14,000 a year! To show that this is not incredible, consider these facts: A tree 12 years old will produce 600 oranges; one 20 years old will produce sometimes 1,500, and an average of 800. Los Angeles oranges are worth $1 a hundred on the spot. An acre contains 400 trees, or thereabout.

The olive orchard of the old Mission San Diego, planted by the *padres* nearly a century ago, since it commenced bearing has never missed a season now these eighty or ninety summers. Under that most droughty and niggard heaven the olive is infallible as the sun—the very emblem of the Divine patience. As with tomatoes, the taste for the olive must be acquired; but once relished, it becomes bread, meat and butter to the people. The great plains of San Diego will one day be as celebrated for this product as old Palestine.

Figs grow without attention; a rootless slip planted in moist ground will bear fruit in three years. Near Santa Barbara a farmer showed me a slip which he had stuck in the ground in spring without root, and watered it, and in the autumn it bore and ripened a fig. Though rather dark-skinned, the figs of that region are already dried and enter largely into sale in San Francisco.

Almonds and English walnuts will grow well without irrigation, and yield only less fabulous returns than the orange. But one must exercise patience, and wait six or eight years. From a tree 11 years old Russel Heath, of Carpinteria, sold in one year $18.50 worth of walnuts. Single almond trees have been known to do equally well. An almond orchard 15 years old will yield $500 per acre.

But of these things enough and too much; we must hasten on to San Diego, where work will probably be soon begun on the Texas Pacific. It is said that the harbor is silting up, and is threatened with ruin unless the channel of San Diego River is changed; but at present, during high tide, the great steamers of the Pacific Mail steam up twelve miles and come alongside the wharfs of New San Diego. In the greater part of the harbor there is never less than 30 feet of water, but it is quite probable that the actual terminus of the railroad may be on the north side of the harbor, several miles out nearer the ocean.

But it is chiefly as a sanatarium that I wished to speak of San Diego. I believe it is generally admitted by physicians that the climatic conditions most helpful to pulmonary affections are a dry atmosphere and an equable temperature. In the first place, San Diego has 13 inches less rainfall than Mentone, 14 less than Genoa, 20 less than Funchal, 10 less than Marseilles, 9 less than Algiers, 33 less than New York etc. The moisture in the atmosphere is generally proportioned to the rainfall. Now, there is Algiers with a rainfall of 19 inches, and on the Sahara, not far distant, the proportion of moisture in the atmosphere is 20 per cent., while in California at times, even on the coast, the proportion of moisture is only 19 per cent., as stated by the Academy of Sciences.

But probably the moisture in the air is not so important a consideration as the equability of the temperature. Between the mean of January and the mean of July in San Diego there is a range of 21 deg., in Mentone 33 deg., in Marseilles 32 deg., in Algiers 23 deg., in Genoa 31 deg., in New York 42 deg., etc. Funchal has a range of only 10 deg., but its rainfall is so much heavier than that of San Diego as to counterbalance this advantage. San Diego is not without its northers, but they are nothing to be compared with the *tramontana* of Italy and the execrable *mistral* of Riviera. Los Angeles has intensely disagreeable sand-storms in the winter sometimes, but they do not reach San Diego.

STEPHEN POWERS.

"TRIAL OF A FAIRLIE LOCOMOTIVE."

No. 9 VICTORIA CHAMBERS, WESTMINSTER, LONDON, 18th March, 1872.

TO THE EDITOR OF THE RAILROAD GAZETTE:

I am satisfied that every engineer who reads your article on this question will at once see its unfairness and its fallacy. It is impossible for me to follow into the region of absurdity which you have reached in this article, but I will just state a fact connected with the trial you refer to, which will show to the uninitiated the wisdom of your main argument, and I call on all who were present at the trial to bear witness to the statement.

The engine in question while *pushing*, not pulling, as you wrongly assert, *slipped frequently, and sand had to be used occasionally to prevent it.* In these few lines the foundation of your elaborate article is completely swept away, and your arguments based on it crumble to pieces.

There is yet another fact which it would be well you laid hold of before committing yourself again so transparently, and that fact is, that under all average circumstances of working with "Fairlie" double-boiler engines, *there is an exact balance between the cylinder power at the periphery of the driving wheels and the adhesion*, or, in other words, the stiction *of these wheels to the rails.*

In the United Kingdom and on the Continent the co-efficient of friction of the driving wheels of locomotives on rails varies from one-third to one-seventh of their insistent weight, according to the state of the rails. In some few cases it is as low as one-tenth; but these are exceptional. If you will calculate the power developed by the Mexican engine, not only starting a train of 303½ tons on a reverse curve, but shoving it up a grade of 1 in 32, gaining speed up to 10 miles per hour, you will find it amount to about 12 tons. Now 12 tons is one-fifth of the insistent weight of this engine, and as one-fifth lays between the maximum and minmum co-efficients of adhesion, that is, between the one-third maximum and one-seventh minimum, it follows that the "Fairlie" double-boiler gives a mean between the two, and thus the right proportions between adhesion and power are maintained.

The want of steam was fairly, and I think it must be admitted reasonably, accounted for by the writer in *The Engineer*. The injectors only worked in fits and starts. The valves in what are usually termed the "black boxes" were rather too tight a fit, and the result was that at times the two injectors would take at once and throw such a stream of cold water into the boiler as would under any circumstances have rendered it impossible to maintain a full pressure of steam with an excessive load up a steep grade.

Another little difficulty was experienced from the blast pipes, the nozzles of which were somewhat too large in diameter. These were slightly reduced when the engine went back to the works for water, and the consequence of this slight alteration was that at the second trial, when there were five more loaded wagons in the train than on the first occasion, the engine started with 120 lbs. of steam, and when she stopped on the 1 in 50 with the train on the reverse curve the pressure was only reduced to 118 lbs., thus showing that during the first trial and with five loaded wagons less the steam in about the same time dropped from 141 lbs. to 90 lbs., while with the second trial and heavier train, after the blast nozzles had been reduced, the steam only fell two lbs. from the starting pressure.*

I hold it to be the duty of all representative journals to report and comment fairly on all matters and things pertaining to or interesting to its readers; but it is the reverse of this, to say the least, to make use of this position purposely to misrepresent, and misdirect those readers. It is neither just nor fair to select *all the bad* about any one thing and dilate upon it while you keep out of sight and are silent on *all the good.* This is what you have persistently done with regard to the principles I advocate.

You endeavor to disparage me and my systems on every possible occasion, selecting only those opportunities where you think you can make a case; but you have

* See *Engineering* and *Iron Times*, Feb. 9.

always failed, and at no time more conspicuously than in this last instance.

Your reference to the dropping of the steam in the Mexican engine could only be taken as meaning that this was a natural result of this type, and some of your readers who may be unacquainted with your mode of dealing, or with the principles of the Fairlie engine, would receive an entirely false and inaccurate impression of its usefulness and value.

To such as these, and in contradistinction to your comments on the steaming qualities of the double boiler, I beg to give the following quotations, taken from an article which appeared in the *Times*, December 26, 1871, on the trial of the Fairlie engines supplied to the Tamboff-Saratoff Railway, Russia:

"It may be assumed that the average gross weight of a loaded wagon is 15 tons, the wagon itself weighing about 6, and each engine is started from St. Petersburg with as many wagons as its hauling power will allow.

"The total length of the section is 78 versts, and in going south from Malovishera, there is first an ascent of 1 in 1,000 for 10 versts, then of 1 in 2,000 for 13 versts, then of 1 in 125 for 17 versts, and then of 1 in 200 for 10 versts, the remaining 28 versts to Okouloosky being level. This ascent has at all times been a great source of difficulty to the management, and with a constantly increasing traffic the difficulty increases in still greater proportion.

"In order to overcome the difficulty the company lately procured some locomotives designed and built in France, with especial reference to the ascent in question. They are of enormous size, with four wheels coupled on each side, and weigh (with tender) from 65 to 70 tons. When first tried, in fine weather, the rails being dry and the adhesion good, these engines took 40 loaded wagons up the ascent. It was subsequently found that this was too much for them to attempt, and that even in moderate weather only 32 wagons could be regularly taken. In winter, still less was practicable, and the number of the wagons had to be reduced with reference to the state of the weather, sometimes to as few as 25.

"The morning of the 1st December was unfavorable for the work, as the snow had fallen during the night and continued to fall during the trial. Notwithstanding this, the stipulated 45 wagons were prepared, and two double-bogie, first-class saloon carriages, each 50 feet long, were placed in the front of them for the accommodation of the spectators. The No. 6 engine was attached to the train thus formed, and started from Malovishera at half-past 8 in the morning.

"The ascent of 1 in 2,000 for 13 versts, which preceded the steep incline, is followed by a short and slight descent immediately before the foot of the steep incline is reached. The trains, however, derive no help from this circumstance, because the slight descent is itself succeeded by a wooden bridge half a mile in length, over which the speed of all trains is reduced to five versts per hour, and all the dampers of the ash-pan are closed to prevent the occurrence of fire from falling cinders. In spite of this diminution of momentum at so important a point, the double-bogie locomotive went steadily and unflinchingly up the hill, with full command of the load. The driver had at first worked with the gear at about 50 per cent. of the stroke, and on getting well upon the incline he increased this to 75 per cent., beyond which he never had occasion to pass. The steam pressure in the boiler was 140 lbs. to the square inch, and *this was so equally maintained that the pressure gauge indicator scarcely moved during the journey.* The firing was in no excess, and everything showed that the engine was working well within the limits of its power. The whole distance of 50 versts, to the summit of the incline, was run in 2 hours 8 minutes, including 18 minutes' stoppage at a station; and notwithstanding the falling snow, no sand was employed, and the engine never once slipped.

"A telegram received by General Keonig during the dinner announced that the fuel consumption of the No. 6 engine from Malovishera to Okouloosky had been 434 cubic feet of wood: and this statement affords another evidence of the value of the double-bogie system. The consumption on the Nicolai Railway during 1870 is stated by the Locomotive Superintendent, Mr. Wall, to have amounted to 200.7 cubic feet for every 1,000 cars run one verst, or for one car run 1,000 versts. This includes the wood used for lighting the fire of the locomotives, getting up steam and shunting, and the quantity is arrived at by dividing the total consumption of the year by the total number of cars run over one verst of the line. The distance from Malovishera to Okouloosky being 78 versts and the number of cars 47, it follows that the experiment was equivalent to running 3,666 cars over one verst. Besides the wood consumed on the journey, there were 60 cubic feet used in lighting the fire and getting up steam, making 494. An addition of 15 per cent. would be a liberal allowance for shunting purposes, and would raise the total to 560 cubic feet expended, as above stated, in hauling 3,666 cars over one verst. This is equivalent to 153 cubic feet per 1,000 cars over one verst, against the average 200.7 cubic feet of 1870. Moreover, the average is taken from one year, whereas the 153 cubic feet is the result of a trial in winter under very difficult circumstances, with snow actually falling and lying to a depth of nine inches upon the ground."

Here we have an engine with five per cent. less heating surface than the Mexican engine, and with wood only for fuel, taking the enormous load of 705 tons, exclusive of engine, in a snow-storm up a continuous ascent of 1 in 125 for 10 miles, with 9 inches of snow upon the ground, while the speed of the engine never varied one-half a verst (less than one-third of a mile) per hour during the passage up, and the steam pressure remained nearly constant the whole time.

These facts being known to you equally well with those stated in the case of the Mexican trial, do you not think, or rather, I appeal to your readers and ask, would it not have been but fair to them, leaving me and my principles out of the question, to have stated the facts of this Russian trial in juxtaposition with those arising out of the Mexican engine trial.

I have an equal personal interest in the Fairlie single-boiler type of engine which you laud, and the double-boiler engine; but I assure all those whom it may concern, that there is no comparison in the usefulness and value of the one compared with the other. In the single-boiler engine I only obtain the advantages due to the double-bogie, which are absence of flange friction and total absence of oscillation. There is no advantage in the generative power of the boiler over that of the same type in the ordinary engine, consequently the saving effected is only that proved by this type of engines working on the Great Southern & Western Railway of Ireland, 5ft. 3in. gauge, to be from 3 to 4 lbs. of coal per train mile, and that due to the economy in the wear and tear of the machinery of the engine, and its types, and likewise to the rails by reason of this absence of oscillation. The direct economy arising from this latter being represented by a reduced coal consumption of 3 to 4 lbs. per train mile.

The double boiler is very different to this. There we get a very large saving in fuel per ton hauled. This is admitted, even by those not over friendly disposed to the engine, to be at least 25 per cent. On the Festiniog Railway it is given as more than 25 per cent.; on the Burry Port Railway it is 50 per cent.; on the Swedish railways 30 per cent.; on the Livny narrow-gauge it is 35 per cent. At the trial on the Great Russian Railway, before referred to, it was proved to be about 33 per cent., and on the Tamboff-Saratoff Railway it has been shown to reach 33 per cent., and from letters received from the Tarapacá Railways, in Peru, it is stated that the Fairlie engines there take double the weight of train that the American engines on that line built by the Rogers Locomotive Company take, and only consume the same amount of fuel. I could go on adding railways whereon this saving is effected by the Fairlie double-boiler engines, but I think I have shown sufficient to convince your readers of the fact. Should, however, any doubts remain on this head, I have appended to this letter the names and addresses of those connected with the railways mentioned, that an opportunity may be afforded those desiring confirmation of the facts of these economies by personal communication.

And now, sir, trusting you will be more just and more generous in future, I am your obedient servant,

ROBT. F. FAIRLIE.

C. E. SPOONER, Esq., Managing Director and Engineer Festiniog Railway, Portmadoc, North Wales.

Capt. LUCKRAFT, General Manager Burry Port and Gwendreath Valley Railway, Burry Port, South Wales.

Messrs. JOHN MORTON & SONS, Nassjo and Oscarshamn Railway, Oscarshamn, Sweden.

ROBT. VON DESEN, Esq., Engineer and Manager Livny Narrow-Gauge Railway, Livny, w. Orel, Russia.

LADILAS KLUPFELL, Esq., Vasily Ostroff 9 Line House Varonine, St. Petersburg, Russia.

N. P. VASSILIEFF, Esq., a lá Direction de chemin de fer Tamboff-Saratoff, Saratoff, Russia.

H. F. ROSS, Esq., Engineer-in-Chief, Tarapacá Railways, Iquique, Peru.

Rails on Longitudinal Timbers.

TO THE EDITOR OF THE RAILROAD GAZETTE:

You invite communications from engineers who have had experience with the use of rails laid upon longitudinal timbers. I once saw the experiment tried and will give you a history of it, together with its result, as well as I can recall what occurred some twenty-five years ago.

When I was a young engineer upon the Grand Trunk road—that part of it then called the Atlantic & St. Lawrence Railroad—the rails for some thirty miles from Portland were laid upon longitudinal timbers. These timbers were of white pine of the best quality, eight by twelve inches in size, and trenailed at the joints to subsills of the same character and dimensions, but four or five feet long. At intervals of four feet these longitudinal timbers were connected by oak planks six by two inches, dovetailed and keyed into the sills by oak wedges.

Cast-iron chairs were used. Those at the joints were comparatively light and flat, with no lip over the flange of the rail. They were let into the timber by a mortise, which brought the chair seat on a level with the top of the timber. A chair of the same description, but only two or three inches wide, and let into the sills in the same manner, was also used under the center of each rail. No effort was made to have the rail joints come opposite each other.

It will be seen that such a track, even at that time and place, must have been quite expensive when compared with cross-ties. *Now* the disparity would be still greater, unless a cheaper material could be used. But my purpose is not to argue the economy of the plans, only to give a history of this particular experiment.

The road was opened, and it is sufficient for my purpose now to say that it was one of the best tracks then in the country. But when I returned to see the road after six years' absence from the State, I found it relaid with cross-ties, and all that could be seen of the original track was an occasional subsill which was now and then exhumed by the track-men.

Was there a good and sufficient reason for absolutely throwing away this whole expensive superstructure, hardly yet begun to decay? Those most interested gave me two reasons which they thought justified them in doing so, and I will endeavor to explain them to your readers.

It is well known that the most critical season of the year for a railroad track is when the frost is "coming out" in the spring. Section-men must be everywhere at the same time, nor stop long in a place. But it happens that just when so much is to be done to any track nothing can be done with the track above described, simply because when the ground is sufficiently thawed to lift the sills the sub-sills will be frozen in hard and fast, and can only be picked out with much expenditure of labor and time. They must be left where they are and the sill raised without them, because time is too valuable to do otherwise. The trenails would still maintain a connection between sill and sub-sill, with more or less ballast interposed; but a few repetitions of this process would disconnect them entirely.

It will be said, perhaps, that this objection can only apply to this particular way of connecting the timber ends, and that a different method of joining them might obviate the difficulty. However this may be, I apprehend that the second reason given me for abandoning the longitudinal system above would apply generally to all track laid upon longitudinal sills, as well as to the combined rail commended by Mr. Densmore in your paper of March 30, and that is *the difficulty of proper drainage.*

With the ordinary cross-tie and a slightly rounded road-bed there are drains to the side-ditches between every tie. No trouble is experienced, because these drains are so short and so frequent. But with longitudinal timbers the drainage must be longitudinal also. The road-bed, instead of being slightly convex, must be very decidedly concave. There must be an interior ditch between the rails, and large openings *under* the sill frequently, to prevent too great an accumulation of water within. The practical effect of all this is easily seen. The sill upon the top of a mound, as it were, cannot be made as secure or tamped as firmly as can a cross-tie upon a level road-bed. A heavy shower upon the best of gravel-ballast and rushing down a forty, fifty or sixty feet grade, to say nothing of steeper ones, will necessarily wash it much more than it would if allowed to escape between every tie into the side ditches. And if, as happens upon many roads, the only ballast is sand, the effect of a heavy sudden rain would be to render the track well-nigh impassable.

But am I arguing the question? Such was not my intention, and lest I be drawn into it, I stop.

St. Johnsbury, Vt., April 4, 1872. A. C. MITCHELL.

Train Dispatching.

CLINTON, Iowa, April 4, 1872.

TO THE EDITOR OF THE RAILROAD GAZETTE:

"Hindoo" gives us a long list of telegraph instructions (to be continued), and gravely asks if they permit a *butting* collision. It seems to me that his trains would be more likely to get flat-wheeled waiting at stations for orders than to have any collisions, butting or otherwise. "Hindoo" claims that by his method he obtained the greatest celerity of movement compatible with safety. I claim that by the American system a single-track road, with proper side tracks, is capable of doing, with absolute safety, three times the amount of work ever performed on an East Indian railway. The American system is not perfected on any one road, though some of the roads doing a heavy business have got very near to a point of safety. There are a great plenty of rules in use on different roads to answer every purpose if they were combined. Here I second "Reformer's" suggestion for a convention of practical dispatchers. Let each one adopt his neighbor's good rules, and discard his own poor ones. However, do not let them do away with holding one train for another until "Reformer" shows them a better way. Although the holding might be dispensed with on a stage road, it is very essential on a single or double-track railroad.

CRANKER.

The Movement of Texas Cattle.

TO THE EDITOR OF THE RAILROAD GAZETTE:

BOSLAND, Kansas, April 1, 1872.

A late number of the RAILROAD GAZETTE, in an article on the Texas cattle trade, states that "after the open lands on the great trail have become too limited for all the cattle," "it is probable the cattle will be shipped either as soon as they have crossed the Kansas border, or in Texas itself." I doubt the correctness of this view. The northward drive begins early in the season, in Texas, and as a general rule, the cattle are not in good shipping condition when they reach the Kansas line. Hence they must either be herded in that region or kept moving northward. In the northward pregress they get fresher and better grasses, and in a great measure escape the torment of flies, which are much more numerous and vicious in Southern than in Central Kansas. This was illustrated in 1871, when it was found that the herds passed Newton, where shipping facilities were established, and kept on to the Kansas Pacific, which handled some 160,000 head, against one-fifth that number shipped at Newton. Some herds even continued on northward to the Union Pacific. The season of 1872 will give us a similar experience. Owing to losses of cattle in Texas through lack of food, in consequence of protracted drought in 1871, the numbers driven in 1872 may possibly fall short of previous years, and they will not be in order when entering Kansas, coming, as they will, at an early day to meet an expected rising market. As they can be kept moving northward to fresher and better pastures as cheaply as they can be herded, and (at from six to

ten miles a day) improve all the time, they will as a matter of course come on toward the line of this railway and most of them be shipped on it. But they will not go to Abilene. By a map of the trail which I send herewith, you will see that its direct course strikes the railway at Ellsworth and west of that point. Ellsworth is 223 miles west of Kansas City, and the point where I write 16 miles west of Ellsworth. Between these is the station of "New Abilene," and at that place, as well as at Ellsworth and Bosland, many herds will be shipped.

The progress of settlements has driven the Texas cattle trade westward to these points, and in another year the shipments will probably be large as far west as Hays and Ellis, respectively 288 and 302 miles west of Kansas City. All this makes a longer haul for the railway, without a corresponding increase in rates of freight; but it grows out of circumstances which bring a large increase of income in other ways, viz.: the extension of farms and towns westward. In a few years the trade will probably be driven to stations beyond Ellis, in a part of the plains where the summer range is ample, and where the grasses are superior for winter pastures.

R. S. ELLIOTT,
Industrial Agent Kansas Pacific Railway Company.

General Railroad News.

ELECTIONS AND APPOINTMENTS.

—At the annual election of the Chicago & Alton Railroad Company in Chicago on the 1st inst., the directors whose terms had expired were: Wm. F. Weld, Boston; John A. Stewart, New York, and Peyton R. Chandler, Chicago. Mr. Stewart was re-elected, and John F. Slater, of Norwich, Conn., and George Straut, of Peoria, Ill., were chosen to succeed Messrs. Weld and Chandler.

—At the organization of the Chicago, Milwaukee & St. Paul Railway Company (which is to construct the Illinois part of the Milwaukee & St. Paul's new Chicago & Milwaukee line) the following were chosen directors: Alexander Mitchell, Sherburn S. Merrill, Hans Crocker and John W. Cary, of Milwaukee; Elisha S. Wadsworth, Henry Witbeck, Anthony V. Van Schaick, John C. Gault and Sanford B. Perry, of Chicago. John W. Cary is President, John C. Gault Secretary, and John Johnson Treasurer. All the Milwaukee members of the board are directors or officers of the Milwaukee & St. Paul, and Mr. Cary, the President, is its General Attorney.

—Elections for boards of directors and officers of the Perth Amboy & Bound Brook and Easton & Bound Brook railroad companies were held in Newark on the 3d. E. M. Patterson was chosen President and Charles Hartshorne Secretary of the former, and Asa Packer President of the latter, Mr. Hartshorne serving also as Secretary of the latter company. Robert Sayre, Chief Engineer of the Lehigh Valley Railroad, was made engineer of the two companies, which the Lehigh Valley controls.

—At the annual meeting of the Lake Ontario Shore Railroad Company in Oswego, N. Y, on the 2d inst., the following named gentlemen were chosen Directors: Gilbert Mollison, A. S. Page, J. G. Kellogg, T. S. Mott, J. C. Churchill, W. O. Wood, James Brackett, J. P. Bennet, Marvin Harris, O. P. Scovell, Burt Van Horn, B. F. Wilson, Chas. Etner.

—O. H. P. Archer, Vice-President of the Erie Railway Company, having resigned, Gen. Alexander S. Diven has been chosen in his place by the directors.

—William H. Patriarche, who was formerly General Superintendent of the Atlantic & Pacific Railroad and has been for some time past General Freight Agent and General Purchasing Agent and also Purchasing Agent of the Missouri Pacific, has retired, and James A. Hill, late General Freight Agent of the Ohio & Mississippi, has been made General Freight Agent in his place. William A. Yore succeeds Mr. Patriarche as General Purchasing Agent of both the Atlantic & Pacific and the Missouri Pacific.

TRAFFIC AND EARNINGS.

—The following is a statement of the earnings of the Central Pacific Railroad Company for the month of

March, 1872	$863,050
Same month, 1871	614,446
Same month, 1870	488,331
Increase this year over 1871	248,604
Increase this year over 1870	374,719
Earnings first three months, 1872	2,027,109
Earnings first three months, 1871	1,636,435
Earnings first three months, 1870	1,292,302
Increase this year over 1871	390,674
Increase this year over 1870	734,747

The increase for the month over 1871 is more than 40 per cent., and for the quarter nearly 24 per cent. There has been a considerable increase of mileage during the past year, but it is not at all in proportion to the increase of earnings.

—The receipts of the Hannibal & St. Joseph Railroad for the third week of March were: 1872, $49,418.57; 1871, $61,052.04; decrease, $11,633.47, or 19 per cent.

—The earnings of the Marietta & Cincinnati Railroad for the month of March were: 1872, $150,789; 1871, $140,744; increase, $10,044, or 7 per cent.

—The earnings of the Toledo, Peoria & Warsaw Railway for the month of March were: 1872, $105,456.77; 1871, $76,957.52; increase, $28,499.25, or 37 per cent.

—The receipts of the St. Louis, Kansas City & Northern Railway (late North Missouri) for the month of March were: 1872, $303,978; 1871, $234,057; increase, $69,921, or 30 per cent.

—The earnings of the Great Western Railway of Canada for the week ending March 15 were: 1872, £21,743; 1871, £17,941; increase, £3,802, or 21 per cent.

—The earnings of the Grand Trunk Railway of Canada for the week ending March 16 were: 1872, £31,100; 1871, £28,500; increase, £2,600, or 9 per cent.

—The earnings of the St. Louis & Iron Mountain Railroad for the month of March were: 1872, $182,065; 1871, $144,637; increase, $37,418, or 26 per cent. For the first quarter of the year the receipts were: 1872, $512,055; 1871, $393,226; increase, $118,829, or 30¼ per cent.

OLD AND NEW ROADS.

Lake Ontario Shore.

At the annual meeting on the 2d the President reported that 52 miles of track are graded and ready for the ties and iron. Two thousand tons of iron are at Oswego, and track laying will commence as soon as the ground will permit. The whole line is under contract from Oswego to Lewiston, excepting across Monroe County. Another year and the road will be completed.

Lake Superior & Mississippi.

It is reported that a lease of this railroad from St. Paul Paul to Duluth (154 miles) has been finally executed. The term is 999 years. This unites the eastern termini of the Northern Pacific and the St. Paul & Pacific, both of which the Northern controls, as it now does the entire railroad system, completed or in progress, of that part of Minnesota north of St. Paul.

Danville, Tuscola & Western.

It has been determined to construct the Danville & Tuscola Railroad, not only from Danville to Tuscola, Ill., but further southwest through to Pana, at the junction of the main line of the Illinois Central with the Indianapolis & St. Louis road, making its entire length about 100 miles. Everything is so far advanced that the contracts will be let directly, if they are not already.

Danville & Paxton.

This company will use the track of the Indianapolis, Bloomington & Western for five or six miles west of Danville, and thence up the Vermillion to Paxton, on the Illinois Central, about 30 miles. It is controlled to a large extent by men interested in the Indianapolis, Bloomington & Western, and is expected to carry block coal for the Illinois Central to take to Chicago.

Walkill Valley.

The first train crossed the great bridge at Rosendale on the 6th inst., and the road-bed is nearly ready to Rondout, and the track is to be completed to that place early in June.

Atlanta & Richmond Air Line.

It is reported that iron enough to complete this road (Atlanta to Charlotte, N. C.) is purchased, and that 16,000 tons will be landed in Wilmington in July.

Atlantic & Gulf.

It was reported recently that six of the directors of this company had resigned because the board rejected a proposition, by Morris Ketchum and associates, to lease the road. The report now is that they resigned because of a difference of opinion of the President, who is also Mayor of Savannah, whom they wished to give his entire time to the company. It is thought that they may withdraw their resignations, and it is also thought that a slight modification in Ketchum's offer of lease will make it acceptable to the majority.

Jacksonville, Pensacola & Mobile.

The transfer of this road to a Receiver was at the complaint of the Trustees of Internal Improvement Fund of the State of Florida, who allege a default in the payment of $472,650, balance due the Trustees upon the purchase of the Pensacola & Georgia and the Tallahassee roads (which together form the Jacksonville, Pensacola & Mobile) in 1869. The appointment was made by Judge Gillis of the Circuit Court of Duval County (Jacksonville).

Kansas Central.

Seven miles of track is laid and grading is going on for 30 miles further. The company has recently received new flat cars, which are 25x7 feet, and on trucks.

Missouri, Kansas & Texas.

This company, it is reported, has made an amicable arrangement with the Missouri Pacific by which its St. Louis freight will go over the latter road from Sedalia. Whether this arrangement is permanent, and will postpone the Missouri, Kansas & Texas' constructing a line of its own from St. Louis to Newton does not appear.

Memphis, Little Rock & Pacific.

It is now reported that Colonel Tate, the President of this company (recently formed by the consolidation of the Memphis & Little Rock and the Little Rock & Fort Smith), has failed to negotiate a lease of the road to the Southern Security Company, which, it has been supposed, completed a contract for it before the consolidation.

International Railroad.

Regular trains commenced running on the 1st to Oakwood, 10 miles northeast of the late terminus at Keechi, 75 miles northwest of Hearne, and within 14 miles of Palestine, where the Houston & Great Northern is to intersect it.

Houston & San Antonio.

This company, which originally intended to construct its line of the 3-feet gauge, has determined to make it of the standard Northern gauge (4ft. 8½in., which many of the Texan roads have), and has let the contract for the construction of 20 miles from Houston westward to the Southwestern Construction Company of Kansas City. This section is to be completed by August, and it is intended to have the line in operation to New Braunfels a year later. The route is by way of Pittsville, Belleville (Austin County), La Grange, Bastrop, New Braunfels and San Antonio, though there may be some deviation from it.

North Shore of Canada.

The contract for the construction of the entire line of the railroad from Quebec up the north shore of the St. Lawrence to Montreal has been let to Dunlap, Smith & Keith, of Chicago, for $7,000,000, a large part of which is payable in municipal bonds, the whole to be completed by December, 1875. Of the firm Mr. George L. Dunlap was recently General Manager of the Chicago & Northwestern, and Perry H. Smith was for some time Vice-President of that company. Both have experience, ability and capital.

Long Branch & Jersey City.

The final surveys have been made, and it is reported that the work of construction will be commenced immediately and pushed through as rapidly as possible.

Central of Iowa.

This company's line now extends from its southern terminus at Albia, on the Burlington & Missouri River Railroad, northward to the Minnesota line 203 miles, 181 miles of which, as far north as Mason City, has been in operation since February, 1871, and the remainder since the 1st of October. The President's report for the six months ending December 31, 1871, gives the following figures. The receipts were:

Freight	$207,671 18
Passengers	77,341 93
Mail	11,000 00
Express	6,000 00
Total	$302,013 11

This is at the rate (the average mileage being 192 miles) of $3,146 per mile per year, and the expenses having been at the rate of about 54 per cent. of the receipts, this should leave about $1,700 a mile to apply to bonds, improvements and stocks.

Atlantic & Pacific.

A bill has been introduced into the Senate to extend for three years the time for completing this railroad.

Northern Central.

One-half of this company's bridge over the Susquehanna at Dauphin was burned on the evening of the 3d, and the loss is estimated in a telegram at $200,000, which is a large amount to burn up in a bridge.

Warsaw & Alexandria Bridge.

A company has been organized in Missouri for the construction of a railroad and highway bridge across the Mississippi between Warsaw, Ill., and Alexandria, Mo., which is but a few miles below the Keokuk Bridge. The capital stock is $800,000.

Toledo, Ann Arbor & Northern.

The contractors, Crane & Thompson, broke ground for the grading of this road from Toledo to Ann Arbor on the 28th ult. at Dundee, Mich.

Springfield, Carrollton & St. Louis.

A preliminary survey of this Illinois line was commenced on the 2d.

Pana, Carlinville, Carrollton & Clarksville.

It is reported that this company has secured money and will let contracts for the construction of a section from Carrollton, Ill., east to the county line very soon.

Macon & Knoxville.

The survey of this proposed Georgia railroad has been completed for 200 miles. A contract has been made with the Central Company for the use of its bridge at Macon, and of several miles of its track north of that place; and a conditional contract has been made for the construction of the entire line.

North & South of Georgia.

The last report concerning this proposed narrow-gauge railroad is that it is graded from Rome to Chambers' Mill, seven miles, and that 60 tons of iron is on hand for the track.

Chicago, Burlington & Quincy.

This company has purchased a steam fire engine, built by Jones & Clapp, of Hudson, N.Y., to be kept at the great shops in Aurora for their better protection. The city has one steam fire engine, but the town is large, and while the engine was coming the shops might burn down. Besides, the city fire department is not quite so effective as the best known. With an engine on the ground and men to man it almost always within call, it will be difficult for any fire to make much headway in the shops (where, too, abundant provision of water is made) before a good stream can be brought to play upon it.

The Mendota & Clinton Branch was completed to the Mississippi River last week, and the company now has lines which reach the Mississippi at Quincy, Keokuk, Burlington, New Boston, Keithburg and Clinton, besides bringing in over its line the traffic from Dubuque.

Cincinnati, Lafayette & Chicago.

This company is now ballasting its track and putting it in order for operation, and it expects to have regular trains running by the 1st of May.

Portland & Ogdensburg.

It is proposed that this company give up its White Mountain route to Connecticut River and Vermont, and build from Cornish to the New Hampshire line, about ten miles, and thence join the New Hampshire Central Railroad to Meredith or Plymouth, 43 miles, and connecting thereby with Wells River, Montpelier, Burlington, St. Johnsbury, Swanton and Ogdensburg.

Knox & Lincoln.

It is proposed to extend this new railroad from its present eastern terminus at Rockland, Me., up the bay to Camden, under the charter of the Bay & River Railroad Company, and it is thought that work will be commenced when the frost is out of the ground.

Maine Central.

A wooden bridge 800 feet long belonging to this company was burned recently. It is to be replaced by an iron bridge, and meanwhile a temporary wooden bridge will be used.

Detroit & Bay City.

Construction will be begun directly. The contract for the first 18 miles out of Detroit has been let to Seymour Brownell, of Utica, Mich.

Lewiston & Auburn.

The managers of this Maine railroad are negotiating for a lease to the Grand Trunk, which is likely to be made.

RAILROAD GAZETTE

Published Every Saturday.

A. N. KELLOGG, *Proprietor.*

S. WRIGHT DUNNING AND M. N. FORNEY, *Editors.*

W. H. BOARDMAN, *Acting Publisher.*

CONTENTS.

Editorial Announcements.

Address.—The RAILROAD GAZETTE *will be printed for the present in New York; our printing house in Chicago having been destroyed. All communications, therefore, whether editorial or business, should be directed to the New York office. The proprietor will receive subscriptions and advertisements at his office in Chicago, Nos. 63 and 65 South Canal street, but letters should be addressed to New York.*

Correspondence.—We cordially invite the co-operation of the railroad public in affording us the material for a thorough and worthy railroad paper. Railroad news, annual reports, notices of appointments, resignations, etc., and information concerning improvements will be gratefully received. We make it our business to inform the public concerning the progress of new lines, and are always glad to receive news of them.

Articles.—We desire articles relating to railroads, and, if acceptable, will pay liberally for them. Articles concerning railroad management, engineering, rolling stock and machinery, by men practically acquainted with these subjects, are especially desired.

Inventions.—No charge is made for publishing descriptions of what we consider important and interesting improvements in railroad machinery, rolling stock, etc.; but when engravings are necessary the inventor must supply them.

Advertisements.—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay, EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and those only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially, either for money or in consideration of advertising patronage.*

LOCOMOTIVE BOILER POWER.

In the RAILROAD GAZETTE of March 2 we commented on a trial made on a branch road in England of a Fairlie locomotive intended for the Mexican Railroad. Our comments have called forth a letter in reply from Mr. Fairlie, an editorial from *Engineering*, and another from *The Engineer*. Mr. Fairlie's letter we publish on another page, and regret that we have not room for both of the editorials referred to. All three of our commentators state that not only must the evaporative power of a boiler be proportioned to the weight on the driving-wheels, but also to the speed at which the power of the engine is developed, and they accuse us of either ignoring or of being quite ignorant of that general principle. We supposed when we wrote what we did that our meaning would be entirely clear. It seems that we were mistaken, and that we erred in not being sufficiently explicit.

We compared Mr. Fairlie's Mexican engine with the ordinary type of American freight locomotive which is employed here for doing fully four-fifths of the freight traffic of the country. Now this comparison was made in order to show the relative efficiency of the two engines for doing the work in which the ordinary American freight locomotive is employed. When we compared Mr. Fairlie's locomotive with those of the American type, we supposed that engines of the former system were intended for the same service as that in which the latter are ordinarily employed. In this it seems we were wrong, as the writer in *Engineering* says: "Engines of the class instanced by our contemporary, on the other hand, having but about two-thirds of their weight available for adhesion, have, as a rule, to develop their maximum power at speeds of from 20 to 25 miles per hour, or say at double the speed *available** in the instance of the Fairlie locomotives, and, this being the case, it would follow that their area of heating surface should be twice as great per ton of adhesive weight as is necessary for the Fairlie engine."

In other words, with the amount of heating surface per ton of adhesive weight, *the Fairlie locomotives can run only half as fast as our American freight locomotives*, and therefore are obviously unfit for at least four-fifths of the freight traffic in this country; because the speed of such trains, practically, cannot be reduced one-half and they perform the service in which they are employed. We are not able to speak so definitely about the freight traffic on European roads, because we know little about it; but the conclusion reached by *Engineering*, in defending Mr. Fairlie's plans, is exactly that to which we came in our criticism of them. We therefore do not see where there can be any difference of opinion between us, excepting upon purely theoretical grounds, in regard to which the writer says:

"It is urged by our contemporary that ordinary American freight engines, having a weight of but about 18 tons on their coupled wheels, have from 900 to 1,000 square feet of heating surface, 'or about 50 feet per ton of adhesive weight,' while it is further stated that these engines 'oftener fail for want of steam than for insufficient adhesion.' Hence the conclusion is jumped at that in an engine having its whole weight available for adhesion, and in which, consequently, the area of heating surface per ton of adhesion weight is necessarily less than in the ordinary American type of engine, the boiler power must necessarily be deficient."

If he had added to the preceding sentence the words "for the service in which the latter are employed," he would have stated our position exactly. He further says:

"The idea that in a locomotive engine the area of heating surface should vary in direct proportion to the weight available for adhesion is certainly novel to us, and we are, to say the least of it, astonished that in a paper like our contemporary, an attempt should have been made to set up such an utterly fallacious standard of comparison as that to which we have alluded. That the standard is really an absurd one very little consideration is requisite to prove."

Now we quite agree with the writer again that such a standard of comparison for engines employed in different kinds of service would be absurd, and we are certainly not stupid enough to take the ground—as our commentators all seem to suppose we intended to—that the speed of an engine is an element which should not under any circumstances be taken into account, when the proportion which the heating surface should bear to the weight on the driving wheels is considered. To illustrate what we mean as clearly as possible, we have had two engravings made, one, fig. 1, representing an ordinary American locomotive, with 15x22 inch cylinders and 5-feet driving wheels. Such engines have usually about 15¼ tons on the driving wheels, or just

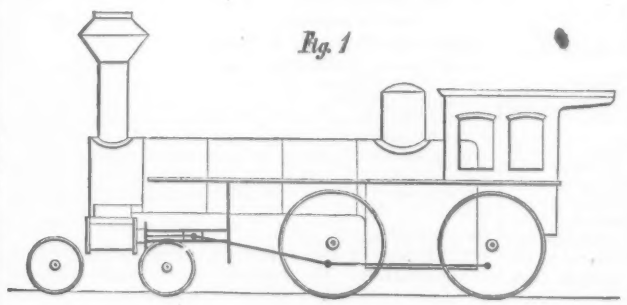


Fig. 1

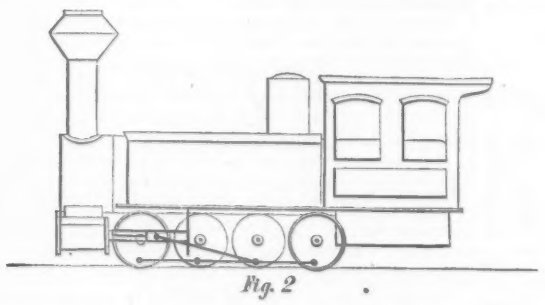


Fig. 2

one-half that on one of the trucks or bogies of Mr. Fairlie's Mexican engine. Fig. 2 is intended to represent an eight-wheel connected tank engine whose boiler and cylinders are exactly like those in fig. 1, but the weight on whose driving wheels is assumed to be just double that on those in fig. 1, and the wheels 30 inches diameter, or one-half of five feet. Supposing now that the pistons of each engine make exactly the same number of strokes per minute, and consume the same quantity of steam, obviously the tractive power exerted at the rail in fig. 2 would be just double that of fig. 1; therefore the adhesion of the second engine should be twice that of the first, and the second would then pull a train twice as heavy as the first, but at *only half the speed*. The boilers and cylinders would be doing exactly the same work in each case.

In the one there are, however, 50 square feet of heating surface to each ton of adhesive weight, in the other only 25. It is not at all important that we should select for this comparison wheels five feet in diameter. If they were 4½ feet the same rule would hold. Or, if we represent the diameter of the driving wheels in fig. 1 by x, the speed by y and the load by l, then, if we double the weight on the driving wheels in fig. 2, their diameter should be $\frac{x}{2}$ and the speed will be $\frac{y}{2}$ and the load $2l$.

The values of x and y must be determined by the requirements of traffic. In this country four-fifths of the freight locomotives have driving wheels either four and a half or five feet in diameter and 50 square feet of heating surface per ton of adhesive weight, so that, taking the ordinary American practice to determine the values of x and y, we are led to the conclusion that if the adhesive weight is doubled without any increase in the size of cylinders or boiler, the diameter of the driving wheels can be only 27 or 30 inches, if the whole adhesion is employed in drawing a train and the boiler does the same work in each case. That it would be difficult to operate our roads with locomotives with wheels of the latter dimensions, we think we need not state. If we attempt to increase the speed by enlarging the wheels, we must also enlarge the cylinders in a corresponding proportion, and also the consumption of steam and the demands upon the boiler. Now it must be shown either that freight locomotives of the American type have more heating surface than is requisite for the work they do, or else that the speed of the Fairlie locomotives must be reduced in the same ratio as the reduction of heating surface to adhesive weight.

Mr. Fairlie seems to think that he has entirely refuted the objections we made to the proportions of his locomotive when he states the fact that "it slipped frequently while pushing" its train. We have a little curiosity to know how English engineers will regard the inference that a locomotive must have heating surface enough because it was able to slip its wheels in pushing a heavy train up a steep incline. It would be very difficult to find a locomotive with *too little* heating surface if this test were to be taken as the proof. In fact, there are very few locomotives which *will not* slip their wheels if worked at a slow speed and full stroke with any considerable pressure of steam, and with sufficient train resistance. It is not the ability to slip under these circumstances which determines whether the cylinder and boiler capacity is sufficient, but it is the capacity to slip when working at the average speed and when cutting off steam at an economical point. If we compare the cylinder capacity of Mr. Fairlie's locomotive with American practice, we will find as much deficiency in that respect as there is in the boiler. In the RAILROAD GAZETTE of April 22, 1871, we discussed the proportions of freight locomotives. We make the following quotations from that article:

"On an ordinary thirty-ton, eight-wheeled locomotive, with four driving-wheels, say 6½* inches in diameter, and with 16x24-inch cylinders, we find that the circumference of the wheels is 193.2 inches, and therefore the locomotive will advance that distance on the track for each revolution of the wheels, provided they do not slip. Each cylinder will be filled twice with steam, which will amount to 19,301 cubic inches consumed, for each revolution, or within a small fraction of 100 cubic inches of steam for each inch the engine moves on the track. From this it may be inferred that with 40,000 pounds weight on the driving-wheels we should have a consumption of steam equal to 100 cubic inches for each inch in circumference of the driving-wheels, or each inch the locomotive moves. From this the following rule may be deduced to get the capacity of the cylinder: *Multiply the total weight on the driving-wheels in tons* (of 2,000 lbs.) *by* 5, *and then by the circumference of the wheels, in inches, and divide by* 4. *The result will be the capacity in cubic inches of each cylinder.*"

Now if we apply this rule—which is deduced from American practice and conformity with which has produced the best results in locomotive performance in this country—to Mr. Fairlie's engine, we will have $\frac{34.7 \times 5 \times 131.9}{4} = 5{,}721$ — capacity of cylinders; which is equivalent to a cylinder 18¼ inches diameter × 22 inches stroke. If, instead of the maximum weight of the locomotive, which is 63 tons (of 2,240 lbs.), we take the average weight, which is given at 55 tons, we would then require by this rule cylinders 17¼q22 inches. That the proportion of cylinder given by the above rule is not extravagantly large is evident from the fact that many locomotives with driving-wheels only 4½ feet in diameter and carrying the same weight have 16x24-inch cylinders, which of course gives a greater relative cylin-

* The italics are ours.

* What are called 5 foot wheels generally exceed 60 inches in diameter. As the tires wear they are reduced in size by turning off.

FIG.

SCALE

FIG. 2

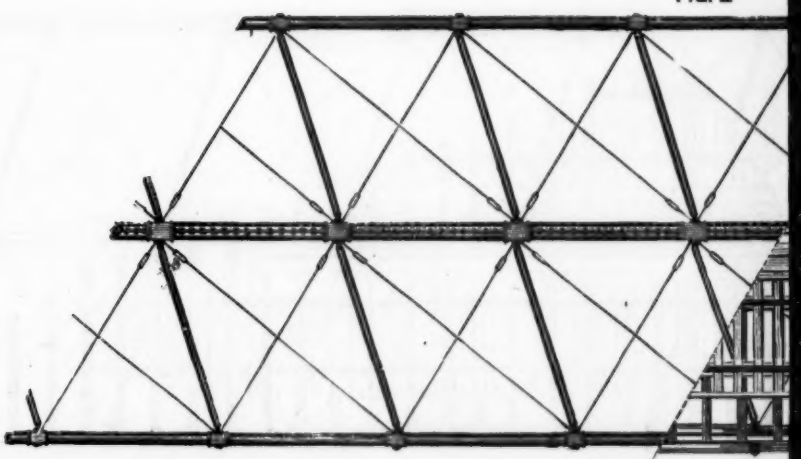
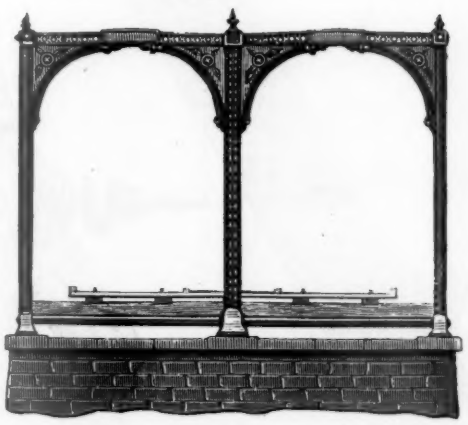


FIG. 3



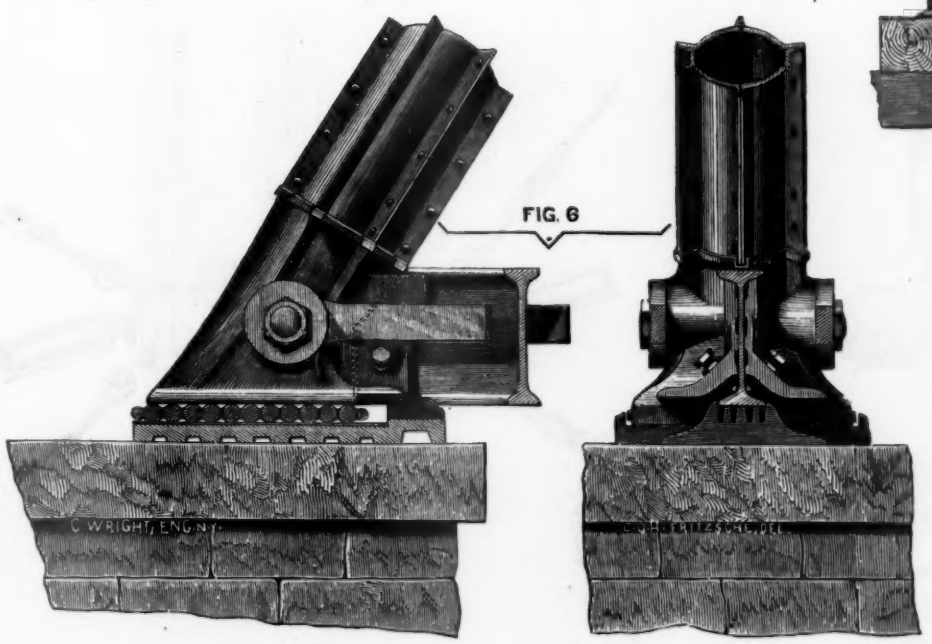


FIG. 6

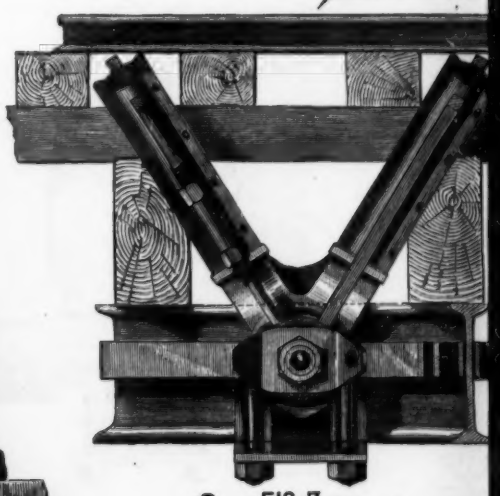
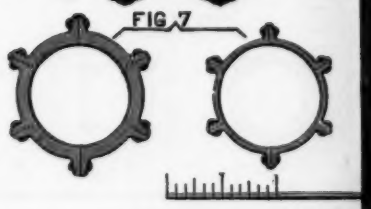


FIG. 7



BELL'S

DELAWARE, LACKAW

CHAS. MACDONALD, BUIL

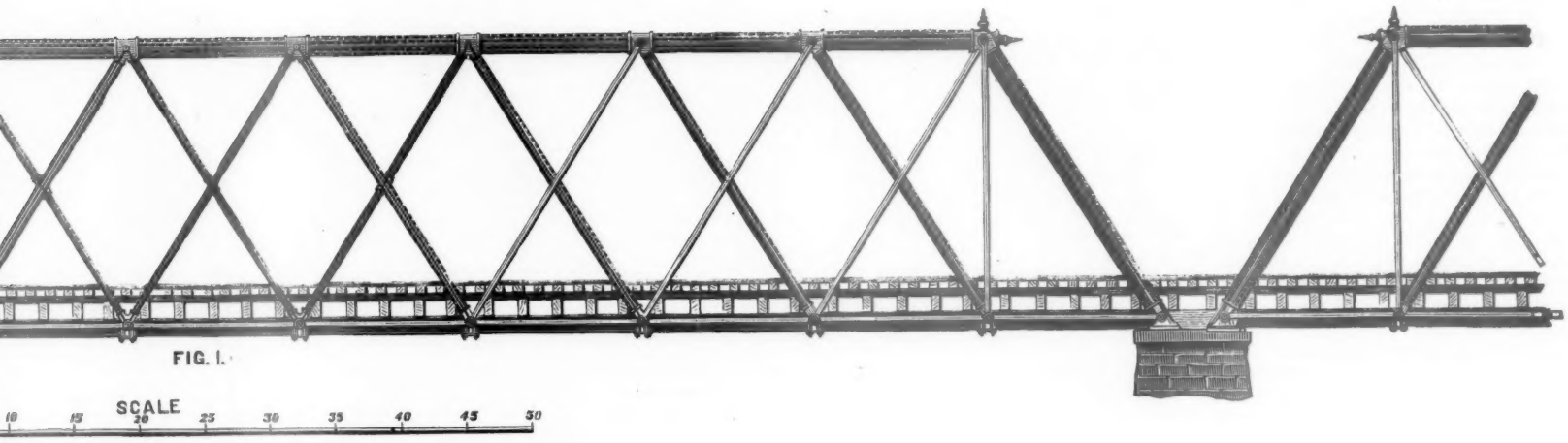


FIG. I.

FIG. 2

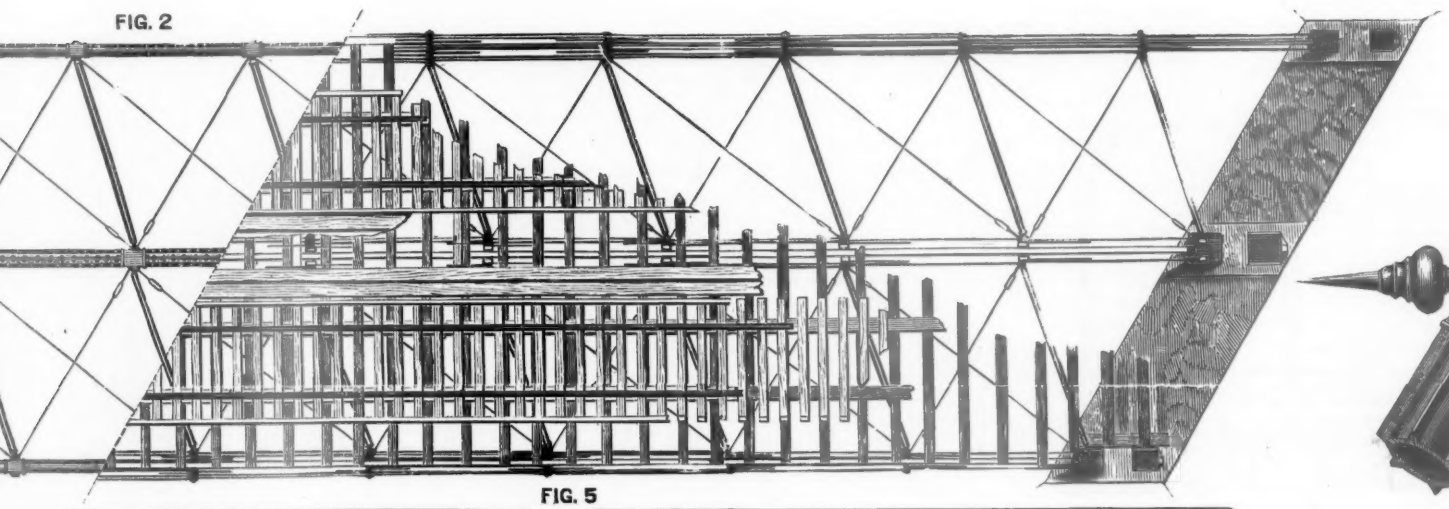
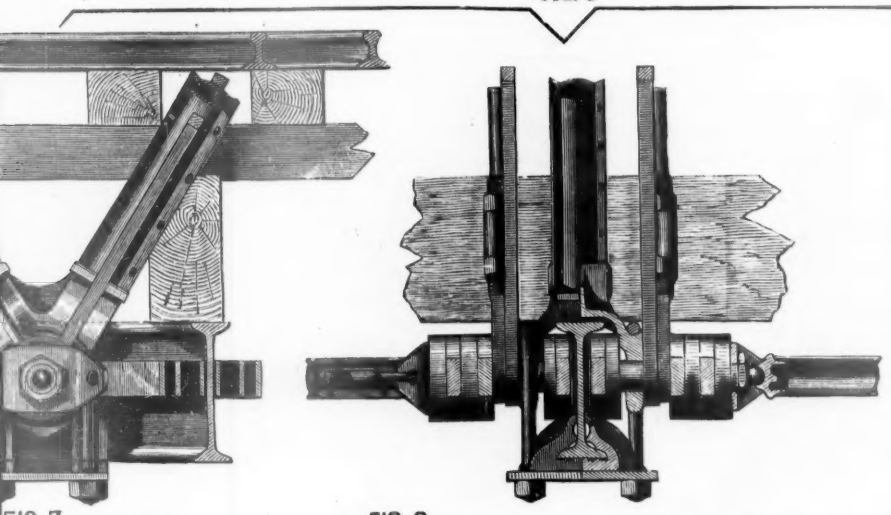
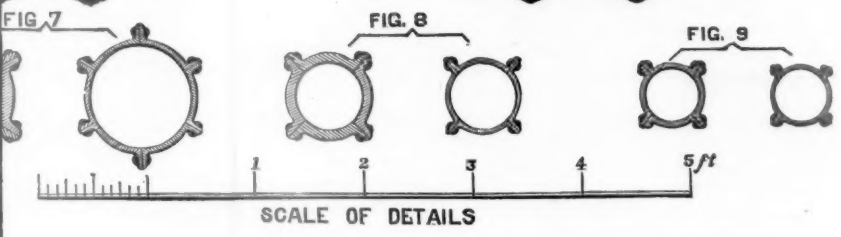


FIG. 5

FIG. 4.





SCALE OF DETAILS

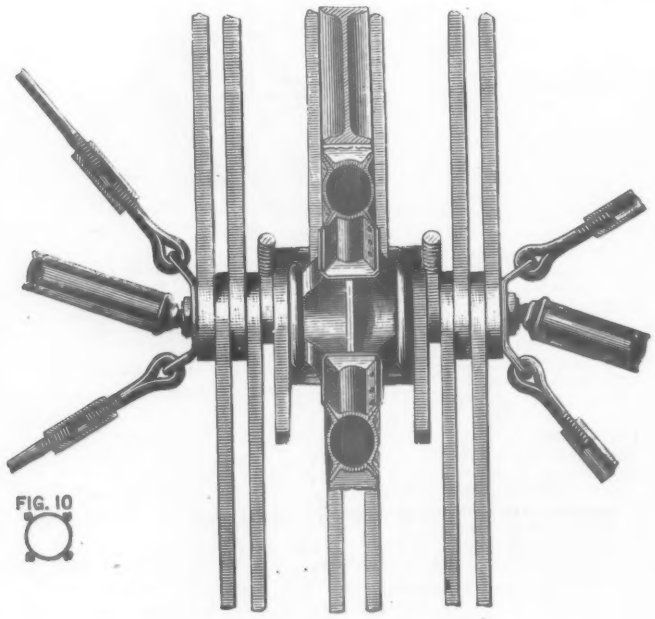


FIG. 10

BELL'S BRIDGE,

DELAWARE, LACKAWANNA & WESTERN RAILROAD.

CHAS. MACDONALD, BUILDER, 80 BROADWAY, NEW YORK.

der capacity than that of engines with 5-feet wheels.

It is evident from this comparison either that the cylinders of our freight engines are much too large or else those on Mr. Fairlie's are a great deal too small. It may, of course, be said that the cylinders on Mr. Fairlie's Mexican engine are properly proportioned in relation to the boiler capacity, and that any excess of adhesion of the driving-wheels can do no harm. This, of course, is true, and his engine can certainly *start* a much heavier train than if it had not so much adhesion; but its capacity for drawing trains long distances is then limited by the boiler, unless the size of his wheels is made very small, and the speed consequently very much reduced. It is of course possible to draw a heavy train a long distance with small cylinders; but to do so steam must be used with much less expansion, and consequently without the same economy that can be realized with larger cylinders.

We do not doubt at all that engines built on the Fairlie system can pull just as heavy trains as it is possible for any locomotive to draw for a short distance or at very slow speed. The ground which we take is, that for ordinary freight traffic and at the speed at which it is requisite to move such trains, it is not possible to get sufficient heating surface to do the work, if all the weight of a locomotive, including fuel and water, is carried on the driving wheels.

For steep inclines with sharp curves which can be operated at a slow speed, Mr. Farlie's engines may be very well adapted; and that he should be able to push—or pull—so heavy a train up so steep a grade and around such sharp curves with an engine whose weight is distributed over such a long wheel base, is certainly very remarkable, and we shall watch its performance on the Mexican road, which has a grade over 20 miles long of 210 feet rise per mile, all the way, and a large part of it consisting of curves of 350 feet radius. It will certainly give Mr. Fairlie's engine and the principle on which it is constructed a severe test.

With reference to the supply of water and fuel *Engineering* says:

"Our contemporary does not adopt the adhesion weight as a unit of measurement for area of heating surface alone, but actually applies it to the determination of the quantity of feed-water and fuel which an engine should carry. Says the writer: 'American engines, of the type we have described, are obliged to carry 1,800 gallons of water in their tanks, or 100 gallons for each ton of weight on the driving-wheels. If the Mexican engine carried the same relative quantity, it would require tanks with a capacity of about 6,200 gallons of water. The same thing is true of the supply of coal. If the adhesion of an engine is increased it can pull a greater load; but the consumption of steam, water and fuel is also increased in the same proportion.' This last statement is true, if distance be taken as the unit of measurement; but not necessarily so if the consumption per unit of time be considered. In other words, the consumption of coal and water *per hour* is not necessarily greater in the case of an engine drawing a heavy load, than in that of an engine hauling a light one. The simple fact is, that if a line be worked with engines drawing very heavy loads, the watering stations must either be closer together than would be necessary if lighter loads were taken, or the engines must be made to carry excessively large quantities of water."

Our readers must certainly observe a most extraordinary unanimity of opinion between our contemporary and ourselves, considering that we are occupying opposite sides of this question. There is hardly anything more certain than that if an engine draws a very heavy train, it will consume a corresponding quantity of water, and that it must either carry a great deal or stop often to take it. On new roads the facilities for getting water are nearly always insufficient, and in many sections a supply cannot always be procured, excepting at points a considerable distance apart. On some of our Western roads it is no very unusual thing to be obliged to carry two tenders with each engine, to supply water in a dry season. On roads with a heavy traffic the inconvenience of stopping often to take up water would be a serious evil, and the general tendency here has been to increase the size of water tanks, until now nearly all 16x24-inch cylinder engines carry not less than 1,800 and sometimes over 2,000 gallons of water. What *Engineering* says is quite true, that "the consumption of water *per hour* is not greater in the case of an engine drawing a heavy load than in that of an engine drawing a light one," that is, if the speed is in an inverse proportion to the load. The difficulty, on our American roads especially, is to locate water stations by the hour. They now occupy positions where a supply of good water can be obtained, and where the stoppage of trains would be of the least inconvenience to the traffic.

We regret that there is not room to reply to some of the specific inquiries made in *The Engineer* regarding boiler capacity, etc. The writer who commented on our article in that paper is not quite as complimentary to us as we might desire, but we doubt whether it will interest our readers much to hear that he thinks our "reasoning is shallow" or that we "know nothing practically about locomotives," but we would like to spare him some trouble. In our previous article we said that it was "impossible, with our present knowledge of boiler construction, to carry all the weight of the machinery, fuel and water on the driving-wheels, and maintain the proper relation between the heating surface and the adhesive weight." In reply to this the writer in *Engineering* says it "proves nothing, except that he does not know everything about locomotives yet." Now if our contemporary is trying to find any proof from the pages of the RAILROAD GAZETTE that any one who is connected with it knows *everything* about locomotives, we beg of him to desist, for he certainly will not find the proof he seeks. The proprietor of this paper has not yet been able to secure the services of such a person.

Of Mr. Fairlie's letter there is not much to say, excepting that he is not quite so observant of the ordinary amenities of scientific discussion as one might think any one who feels secure in the position he occupies might be. Of his complaint that we have not done him justice in our columns our readers will be best able to judge. He has always had whatever space he asked for, and we have published his communications without abridgment or modification, and we have had some complaints that too much room has been devoted to Mr. Fairlie and his projects. If his engines will do all that is claimed for them, then our criticisms can have but little influence. If they have not the advantages which are claimed for them, the sooner our railroad managers know it the better.

Bell's Bridge.

Bell's Bridge carries the Delaware, Lackawanna and Western Railway over a tributary of the Delaware River, about one mile above the famous Water Gap. It is a three-span double-track wrought-iron bridge, having a web system of double equilateral triangles, and entirely self-adjustable on heavy pin connections in top and bottom chords. It was completed early in the present year, and replaces the wooden structure in use since the opening of the railroad. The removal of the old bridge and the erection of the new one were effected without interfering with the traffic by turning both tracks through one span, and erecting the middle and outside trusses of the new bridge on the lower side of the piers. After the new track was completed the rails were shifted, and the old middle truss and track removed, the remaining outside truss being temporarily retained as a false work for the new second track.

Fig. 1 in the accompanying plate represents an elevation of the middle truss of the center span. Its length is 143ft. 11in. between centers of end piers—the span to the right is of the same length, while that to the left is 91ft. 7in. long. Figs. 2 and 3 represent a plan and end elevation of the same span, in which it will be noticed that there is a considerable angle of skew, and that the lateral system is attached directly to the panel points, where it properly belongs. A detail of the connection is given in fig. 5. The compression members of the truss are composed of rolled columns, varying in section and diameter to the strain brought to bear upon them. For the top chord and end post of the middle truss fig. 7 gives the limit of section. Fig. 8 applies in the same manner to the top chords and main braces of the outside trusses of the longer span and to all the trusses of the 91ft. 7in. span, as well as the intermediate braces of the longer middle trusses.

Fig. 9 represents the size of column used as counter-braces in all trusses, while the lateral struts are shown in fig. 10. These columns are all turned up square in the shops and cut to exact lengths. The cast joint boxes against which they abut are also turned square, and receive the columns upon a projecting tenon, to hold them in place radially.

The tension members are flat bars, upset at each end by hydraulic pressure, with pin holes drilled accurately to lengths between centers. When counter braces are used, the tension rods running in the same direction are furnished with turn-buckles to insure uniformity of action. After the rods are secured to the proper bearing against the braces, their adjustment must be perfect.

The track is sustained upon a rolled I beam, as shown in fig. 5, in the center line of the bottom chords by yoke hangers, resting upon legs cast on the ball casting. This beam is cut in lengths one-sixteenth of an inch less than the panel lengths, and is held firmly against fitting ribs on the under side of the ball casting, but no tensile strain from the chord is brought to bear upon it.

Fig. 6 shows the end casting with this chord beam and its connections, two set-screws being used to hold it firmly upon its bearing. By this arrangement of track a local engine load is uniformly distributed over a member which is in the most economical form to do this duty, and by it is transferred in exactly equal proportions to the web system, which could not be realized if the I beams were suspended across the line of track, which in this case would be particularly objectionable, on account of the angle of skew. The addition of cross-ties projecting over the longitudinal rail joints, although it increases the weight, is found to be necessary on this railroad, in common with others having a large coal tonnage, to insure greater safety to the structures in the event of a coal car getting off the track, which has already been the case upon this bridge. All the parts of this bridge are sent to the ground in condition to be erected without further machine labor, and such is the facility with which their combination can be effected that a span has been swung clear of the false works in less than two days with a gang of 25 men.

The strains have been calculated upon the assumption that the maximum rolling load upon each track shall be an engine and tender, weighing 65 tons in a distance of 50 feet, with a train load of one ton per foot lineal. The mean strain per square inch upon wrought-iron in tension is 10,000 lbs., and for columns the section is determined by Gordon's formula. The turn-table truss is of double the strength of the outside ones. The actual deflection of the outside truss, 143ft. 11in. span, under a heavy coal-hauling engine, with loaded coal train, running at a speed of eight miles per hour, was ⅜in., the middle truss being ¼in.

Mr. Macdonald, engineer and contractor for this bridge, is now completing the second track of a 91ft. 7in. span, similar to the short span in this case, about four miles further up the line, and previous to the completion of Bell's Bridge had furnished a two-span deck, called Ransberry's, six miles above, upon the same general plan.

A New Gulf Port.

A great Texan harbor is contemplated seriously, according to trustworthy reports, which, if the combination indicated is made, will probably be *the* port of Texas, and seriously affect the prosperity of Galveston, now the chief city of the Gulf west of New Orleans, and unmistakably the chief port of Texas. The new project is to construct a harbor at the mouth of the Brazos, which is about forty miles southwest of Galveston, and nearly due south of Houston; construct a railroad from it to Houston, and do this by the combined managers of the Houston & Great Northern, the Houston & Texas Central, the International and the Houston Tap & Brazoria railroads, whose traffic to the Gulf is to be directed over the proposed road and to the proposed harbor. These roads together have probably nine-tenths of the mileage now existing in Texas, and they would leave Galveston (at present) only the 50 miles of railroad to Houston and 84 miles from Harrisburg west to Columbus. Such a plan seems wild, but it is not really so wild as it seems. Texas is a new State, and Galveston, though its chief city, is still not a great city; and it might be easy to build up a rival which shall eclipse it when such an effort would be hopeless in the case of a city as large as St. Louis, Chicago, or even Savannah or Charleston, in which the capital invested in business and the facilities for doing business may readily bear comparison with the capital represented by the lines for transportation.

William E. Dodge, Walter Phelps, and other capitalists who are largely interested in the railroads named, have recently been in Texas and have examined, and, it is reported, considered favorably this scheme. Large purchases of land at the mouth of the Brazos have been made by certain directors, and surveys have been made which, it is said, show that at a comparatively small expense a harbor can be made at that point superior to any now in Texas, having 18 feet of water at the entrance, whereas Galveston has but ten.

If all these railroad companies unite and succeed in making a good harbor, it is hard to see what can prevent their creating a considerable city there and making a great deal of money out of it.

The chief reason for distrusting such a movement is not its boldness, nor the amount of capital required for the construction of a new harbor or the establishment of a new city, but the difficulty of combining so many different corporations, presumed to be, in a degree, rivals, and uniting them permanently in harmonious action. But when one studies the composition of these Texas companies he finds that their members are not generally antagonistic, are indeed in great measure identical. The Houston & Texas Central and the Houston & Great Northern are to a very great extent owned by the same men. Men holding a majority of the stock in one, also, we believe we may say, hold a majority of the stock in the other. They are also represented in the International, though probably not to the extent of absolutely controlling it; and the Houston Tap & Brazoria is pretty much in the same hands. The latter will give a route from Houston half-way to the mouth of the

Brazos, leaving only about thirty miles of road to be constructed to complete the outlet.

Another fact adds to the facility with which such a system can be established and operated with a common outlet, and that is their common gauge. All but the Houston & Texas Central now have the standard gauge of 4ft. 8½in., and the latter will soon change its 5ft. 6in. gauge to the standard, with which its new branch, the "Waco Tap," is already laid. It will preserve the wide gauge on its Austin Branch until it has worn out its rolling stock, but will have the standard gauge on its main line very soon.

Now the Galveston, Houston & Henderson road, which at present is the only outlet to the Gulf for all these roads, has a gauge of 5ft. 6in., and its proprietors control the Galveston, Harrisburg & San Antonio Railroad (which extends from a point on the former road a few miles south of Houston westward 84 miles to Columbus), which has the same gauge. The former, of course, can only be used as an outlet to Galveston, and the interests of the proprietors will of course influence them in favor of operating the two roads together; though the latter could be, conveniently enough, so far as its location is concerned, made to feed the Brazos outlet.

The mileage of the roads said to have entered into this combination is as follows, *counting only that already constructed*, and three of them at least are making rapid progress:

Houston & Texas Central	354
Houston & Great Northern	98
International	85
Houston Tap & Brazoria	50
Total	587

The Houston & Texas Central, when completed to Red River (as it will be in a comparatively short time), will be about 500 miles long, including branches; the Houston & Great Northern about 350 miles, with a branch which may be made 150 miles long, and the International 600 miles. The Houston Tap & Brazoria, now terminating at Columbia, 50 miles (by a circuitous route) from Houston, it is proposed to extend westward to San Antonio, 200 miles, and beyond.

The strength of a combination of the leading stockholders of these roads may be inferred when it is known that among them are William E. Dodge (President of the Houston & Texas Central), William Walter Phelps (President of the Houston & Great Northern), Moses Taylor, and other capitalists.

This is a striking illustration of the tendency in this country—in the newer part, that is—to unite real-estate interests with railroad enterprises. The fact being that most railroads in new countries add to the value of the land much more than their gross cost, and very much more than they return to their proprietors from their traffic, for many years at least, it is natural that those who pay for the railroads should desire to at least share in the profit which arises from the increase in the value of the land. They very generally do this by procuring the land where stations are established, and where towns, larger or smaller, are likely to grow up; but it is not often that they have an opportunity to establish, and, to a great extent, own and control a seaport which is likely to receive the larger part of the products of a vast territory. The Northern Pacific expects to do this through the ownership of a large part of Duluth, at its eastern terminus (a lake port, not a seaport), and of as much as it shall choose, probably, of its Pacific coast terminus; and the Texas Pacific will probably do it with San Diego. As in these cases the entire value of the places is made by the railroads, it is not so unfair that those who build the railroads, and through them the towns, should gain something from the latter, especially as, for many years at least, the former make them no returns.

The New York, West Shore & Chicago Railroad.

This company has now no less than ten engineering parties in the field between New York and Buffalo. The line is mostly located from Hoboken to Catskill along the Hudson, being everywhere near the bank of the river. There will be some heavy work on this part of the line, but we are informed that the line, so far, will have no grade of more than ten feet to the mile. From Catskill to Buffalo the line is not finally located, but preliminary surveys have been made with considerable care, and we are assured that a route is secured which will have nowhere ascending grades of more than 30 feet to the mile going west, and 20 feet to the mile going east, in which latter direction the bulk of the traffic is moved. Thus it will be seen that for grades the line compares favorably with, and in fact very much resembles those of the Canada Southern and the Canada Southern & Chicago; and it resembles them also in a neglect of local traffic, the leading aims being, evidently, first, easy grades; second, good alignment, and third, directness; and the statement is made that, with the first two advantages secured to an extent hardly equaled on any long line in the country, and not approached by any line from New York westward, it has also a route between New York and Buffalo 30 miles or more shorter than that of the New York Central & Hudson River.

It also appears that a number of the leading stockholders of the Canada Southern are engaged in this enterprise, and it is natural to conclude that it is intended to form the eastern section of a new low-grade line from Chicago to New York designed especially for through traffic, and more especially freight traffic. It is to have a double track, steel rails, and iron bridges from the first; and everything indicates that its managers expect to have a very large traffic from the beginning. As we have shown, it can expect only a very limited local traffic, at least for some time, and this large traffic must therefore be through; and as the rates on this are very low, and the profits usually small, it will be necessary to carry a great deal of it to make a good return on the capital. But there is hardly any limit to the traffic which may be secured from the Northwest, *if the rates are low enough;* and if the managers of the new line have faith in the principle, so often enunciated, that a railroad with low grades and loaded freight trains as near together as they can be run with safety can transport merchandise profitably at rates vastly less than those prevailing, and no more than those charged by vessels, they can doubtless make the experiment with confidence that business will not fail them, whatever may be their profits—or losses.

To Train Dispatchers.

Mr. W. W. Wells, Superintendent of Telegraph and Train Dispatcher of the St. Louis & Iron Mountain Railroad, has issued a circular to all train dispatchers, which is as follows:

The question of a general system of "train dispatching" for the railroads of the United States is becoming a most important one, and I consider it to the advantage of all railroad companies, and those interested in their management, to co-operate in my efforts to call together a convention of chief train dispatchers from all parts of the United States and Canada, for the general interchange of ideas, the establishment of the best and most uniform system of train dispatching, and, if deemed desirable, to form an association, to hold stated meetings, and the appointment of committees to report upon such business as may come before the convention.

I would therefore respectfully suggest the propriety of your consideration of this matter, and would be pleased to have your views upon same as soon as possible, in order to make the necessary arrangements for assembling the convention at such point as may be decided upon.

This seems to us an eminently proper step to take. The discussion of the subject, both in our columns and in those of the *Telegrapher*, has become quite general, and, we think we are safe in saying, is likely to last some time yet; and by the time a convention can meet, dispatchers generally will be awake to the subject and have done a good deal of thinking on it, and therefore be in the best possible condition for profitable discussion. A number of dispatchers have already proposed a convention in our columns, and others have expressed themselves in favor of it. We hope that dispatchers generally will reply to Mr. Wells, and give him their opinions as to, first, the propriety of holding a convention; second, the time and place.

THE ERIE SHAREHOLDERS, it is reported, are all in harmony at last, the Bischoffsheim & Goldschmidt lion having lain down with the Heath & Raphael lamb (though there is some reason in this case to believe that the lamb is inside of the lion). Consequently it is supposed that there will be no contest at the July election; but the present managers will be able to take a new lease of power for a year. Just what the terms of the compromise were does not appear, whether an agreement for a division of offices and control, an agreed plan of management acceptable to both parties, or an absolute sale of their shares by the Heath & Raphael party. This latter would be the severest revenge that could be taken on their late adversaries for seizing their property without their consent.

Now a majority, and if reports are true a very large majority, of the shares being controlled by one party, there is no reason to oppose any disposition it may make with the property not opposed to the public interests. If the proprietors make a lease of the Erie to the Atlantic & Great Western, or pay an extravagant rental for the Atlantic & Great Western, let them do what they will with their own. We cannot say too much against the manner in which a few men took possession of the Erie Railway without consulting and against the wishes of those who held a majority of the shares; but since the latter have acquiesced and agreed to trust the property to those who thus seized it, no one else has a right to complain.

THE MISSOURI RIVER is a peculiarly intractable and unstable stream, not only refusing to follow the path which engineers may mark out for it, but, often turning from the path of its own choice, it may at any time seek, literally, "fresh fields and pastures new," so that the banks that knew it once may know it no more forever. This unstable character of the Big Muddy (which seems to have been made long at the expense of its depth, and at some seasons is hardly navigable for canoes for 2,000 miles or more of its course below the "head of navigation" in Montana) makes it a peculiarly troublesome stream to bridge; as it would be extremely provoking, to say the least, to put a million or two of dollars in a bridge one year and find the river one side of it the next.

One of the chief difficulties in determining and limiting the channel of this stream is the peculiarly light and friable character of the material which forms its bed, and in many places its banks. This is commonly called sand, but it is lighter and more soluble than sand proper, and has an attachment for water almost like a chemical affinity, so that a little moisture in motion sets it floating. Naturally, when works have been constructed *on* this treacherous soil to turn the current, the water has excavated it from under them and breakwaters and all have either gone down stream or sunk in the sandy bed. To go down to the rock involves a great expense, usually not warranted, and consequently the greatest pains have been taken to secure bridge sites where the banks are more than usually stable and the current fixed.

In constructing in the St. Joseph Bridge, Col. E. D. Mason, the Chief Engineer, overcame the difficulties in constructing the breakwater by making it of brush-wood, through which the water flowed with considerable freedom, with the heads up stream. This light and permeable structure was laid simply on the surface of the river-bed at low water, fastened in place with small piles, and weighted down with sand. Now when the water undermined the bed at the upper edge of the breakwater, the brush simply tipped downward and were imbedded and firmly held, as the engravings which we give elsewhere with the report clearly show.

WE call particular attention to the report of the Massachusetts Railroad Commissioners on railroad accidents, the concluding portion of which we publish in this number of the GAZETTE. Their investigation was evidently most thorough, being aided to the utmost by nearly all the railroad managers in the State and many out of it, and their conclusions are worthy of careful consideration.

THE ST. JOSEPH ENGRAVING COMPANY should be credited for the excellent woodcuts on the 159th page illustrating Colonel Mason's report on the St. Joseph Bridge. In fitting them to the page it was found convenient to cut off their imprint. The work would be creditable to any establishment, and is especially notable as coming almost from the borders of civilization.

OLD AND NEW ROADS.

[*Continued from page* 163]

Valley Railroad.

A party of engineers under Mr. W. F. Dandridge is making an experimental survey from Staunton southward to ascertain whether, with a maximum grade of 75 feet per mile, Lexington can be made a point on the line.

Memphis & Knoxville.

Concerning this proposed narrow-gauge railroad the Memphis *Avalanche* says:

"This important road, intended to run on as straight a line as possible through the center of the State, obtained its charter in January last, since which time surveys have been made from Memphis to Bolivar, and all the right of way procured, with the exception of a small portion near Memphis. The very liberal subscriptions made to the stock of this road by people and towns along the line are such as to justify the directory in letting the work as soon as it can be finally located. Engineers are now making the final location between Memphis and Somerville, and as soon as they are through the work will be let, probably by the 15th of next month. This road will cross the Somerville Branch of the Memphis & Charleston road at Somerville; the Mississippi Central at Bolivar; the Mobile & Ohio road near Bethel Station, and reach the Tennessee River opposite Savannah."

Memphis & Mississippi City.

This newly organized company purposes to construct its line from Memphis south by east, not to Mississippi City, which is on the Gulf at the southern border of the State of Mississippi, but to a junction with the Mobile & Northwestern Railroad.

Iowa Eastern.

This is the new name of the company which is to construct a railroad from Des Moines northeast to McGregor, Iowa, forming a route to Milwaukee. It is expected the money for its construction will be secured and work commenced directly.

Burlington & Missouri River.

We learn that this company has discharged without prosecution most of the conductors and station agents lately arrested for embezzlement, all having confessed their guilt. Goddell, it is reported, is considered the projector of the entire scheme and will be prosecuted. It is much to be feared that the punishment simply by discharge from employment of men clearly proved to have been engaged in robbing their employer will not have the effect to impress others with the guilt and danger of such conduct.

Atlantic & Great Western.

It is reported in Ohio that this company seriously contemplates the construction of a branch from a point above Springfield southwest, through Springfield, Xenia and Lebanon to Cincinnati, to be used instead of the broad-gauge track of the Cincinnati, Hamilton & Dayton road from Dayton southward. This would shorten the route to Cincinnati somewhat, but it would leave the section from the junction to Dayton comparatively useless, and would be through a country where the railroads are already pretty numerous. The Cincinnati, Hamilton & Dayton now takes into Cincinnati from Dayton and other stations the trains of several lines, and their combined business gives it a good traffic; but the new Cincinnati & Springfield Short Line, now nearly completed, will divide this traffic, and a line for the sole use of the Atlantic & Great Western of course would have less than the others with the traffic of two or three lines each. The project is regarded with much favor at Springfield, which is left a little to one side by the present road, and the *Republic* of that place says: "It is an apparent fact that

the Atlantic & Great Western Company will be forced to do something of this sort or fence in its track. The idea of building a long line of railway with the purpose of avoiding all large towns and all avenues of business was worthy of the wooden-headed and bull-headed gentlemen who originally located the road. A line from Hunt's Station, four miles above Springfield, through this city, Xenia and Lebanon, would pass through the richest agricultural region of Ohio, open a large tract of new territory to railway facilities, and reach an immense aggregate of passenger and freight custom."

Galveston, Harrisburg & San Antonio.

This Texas railroad, formerly the Buffalo, Bayou, Brazos & Colorado, is now in the hands of parties who have a large if not a controlling interest in the Galveston, Houston & Henderson. It having been reported recently that Charles Morgan had purchased the road, the President, Mr. T. W. Pierce, of Boston, denied it utterly.

Cattaraugus County Railroad.

The route of this line is from Salamanca, where the Erie and the Atlantic & Great Western meet, to Machias, on the Buffalo, New York & Philadelphia branch of the Erie, in connection with which latter it will give the Atlantic & Great Western a tolerably direct outlet to Buffalo, which is a desirable thing. General McClellan, President of the Atlantic & Great Western, has telegraphed that his company will undertake the construction of the road immediately.

Texas Pacific.

In reply to a telegram from their representative in Congress, with reference to the acceptability of the proposal of the Texas Pacific to begin construction at San Diego in two years and complete 25 miles per year thereafter, the Chamber of Commerce of that town has telegraphed that the proposition is not acceptable, that one to begin construction at that end this season and complete 25 miles per year would be, and that if the company does not accept the latter, it asks that the franchises be transferred to some company that will.

Wiscasset & Kennebec.

Surveys have been made for this proposed railroad from Wiscasset, Me., where there is a fine harbor, up the valley of the Sheepscot River through the towns of Alna, Whitefield and Chelsea to Augusta or Gardiner. It is proposed to make it of 3-feet gauge.

Central of New Jersey.

This company has declared the usual quarterly dividend of 2½ per cent. on the full stock, and interest to the 31st instant on the new script at the rate of 7 per cent. per annum, both payable April 20, at the office of the company, 119 Liberty street.

Nashville & Chattanooga.

The Nashville *Banner* says: "For the past sixty days the Nashville & Chattanooga Railroad has had all the freight it could possibly move, and the pressure is steadily augmenting. During the month of January, 3,100 loaded and 500 empty cars were sent south over that road. In February, having two days less than the previous month, 3,140 loaded and 400 empty cars were forwarded in the same direction."

Parkersburg, Ripley & Charleston.

The Charleston (W. Va.) *Journal* states that the directors have authorized the President to contract for the construction of this road out of Charleston as far as the Two-Mile Valley, where are deposits of coal, iron and limestone. It is proposed that Parkersburg and Wood and Jackson counties shall subscribe toward the completion of the work to Parkersburg.

Petersburg Railroad.

At the annual meeting in Petersburg, Va., on the 21st ult., the directory was authorized to negotiate the sale of $500,000 eight per cent. bonds, secured by a second mortgage on the property of the road, in coupon or registered bonds, which may be converted at the pleasure of the holder. Of the former issue of a half million dollars, but $158,000 remains, out of which $17,000 will have to be drawn to pay money borrowed to meet a negotiable note. This, it is understood, is intended to provide for an extension of the road to City Point.

Fredericksburg, Orange & Charlottesville.

The company has notified the Virginia Board of Public Works that it accepts the provisions of the act passed by the General Assembly extending its charter. The Fredericksburg (Va.) *Ledger* learns that the company will advertise for bids as soon as a survey can be made, which, it is thought, will be inside of one month. The report is given that the road can be completed to Orange Court House in three months from the time work is commenced, and that in all probability work will be begun in April.

Wheeling & Tuscarawas Valley.

It is reported that this company has made a contract for the construction of its road with New York men for $35,000 per mile, $10,000 to be paid in cash, $10,000 in stock, and $15,000 in mortgage bonds, 20 miles to be made ready for the iron before the money is paid.

St. Louis & St. Joseph.

A new company of this name has been organized in Missouri, whose purpose, according to its charter, is to acquire the old St. Louis & St. Joseph Company's road, extend it to the St. Joseph Bridge and about a mile into the city of St. Joseph. The capital stock is $1,000,000.

Cincinnati & Springfield Short Line.

A correspondent informs us that last week the track-layers working from Dayton southward had 12 miles of iron in place, and on the 1st inst. a party was to begin laying iron northward from the junction with the Marietta & Cincinnati road, seven miles above Cincinnati. The entire track is to be laid by the 1st of May.

Lafayette, Bloomington & Mississippi.

The last rail has been laid and the line is now continuous from Lafayette, Ind., to Bloomington, Ill., and will soon be opened and operated in connection with the Toledo, Wabash & Western, to which it is leased.

The Massachusetts Commissioners' Report on Railroad Accidents: Their Frequency, Causes and Means of Prevention.

[CONCLUDED FROM PAGE 158.]

Passing from the consideration of accidents arising from the various causes against which it is almost impossible in the nature of things for the companies to provide, it was found that the other class of casualties could generally be traced to some defect under one or more of the following heads:

(1.) Derailment by breaking of axle or rail.
(2.) " by expansion of rail.
(3.) " by defective switch.
(4.) " by reason of insufficient cattle-guards.
(5.) Collisions caused by carelessness of employees.
(6.) " " by imperfect regulations.
(7.) " " by defective signals.
(8.) " " by want of telegraphic communication.
(9.) " " by want of brake power.
(10.) " " by railroad grade-crossings.
(11.) " " by breaking through bridges owing to want of guards.
(12.) " " by falling of train through draw.
(13.) " " by concussion in starting or stopping train.
(14.) " " by falling between cars while passing through train in motion.
(15.) " " by explosion of locomotives.

Apart from anything peculiar to the management of the Eastern Railroad Company the following causes of a general nature seem to have essentially contributed to the occurrence of the Revere disaster.

1st. A deficiency in the system of signals by which an interval either of space or of time was insured between trains following each other;

2d. The want of a complete telegraph system which should keep the central office fully advised at all times of the exact position of each train on the road, and in communication with all of such trains at the several stations;

3d. To an insufficiency of brake power;

4th. To the use of tail-lights of insufficient penetrating power.

This special analysis of causes, together with the preceding general one, the Commissioners compared with two other similar analyses of causes of accidents which had happened in Great Britain; the one made by Mr. Brunlees and submitted to the Institute of Civil Engineers,* and covering the years from 1854–60 inclusive; the other contained in the report of Captain Tyler already referred to.

That of Mr. Brunlees was as follows:

Insufficient accommodation	58
Insufficient establishment	61
Want of engine power	17
Want of brake power	65
Want of communication with locomotive	31
Want of adequate signals	88
Want of time-pieces	15
Want of turn-tables	2
Unpunctuality	50
Insufficient or badly enforced regulations	198
Insufficient interval between trains	70
Negligence of employees	211
Speed too great for class of road	8
Want of electric telegraph	97

Out of 975 causes contributing to the accidents analyzed in making this table, 729 were common to it with the analysis made by the Commissioners of Massachusetts accidents.

The analysis of Captain Tyler (Report, p. 33) refers the accidents investigated, 122 in number to the following contributing or combined causes:

Fractures of coupling	4
Defective maintenance	9
Defective construction	12
Defective accommodation for traffic	16
Insufficient or inexperienced staff, or too long hours of duty	12
Insufficient brake power	10
Defective signal and switching arrangements	60
Want of means of ascertaining correct time	2
Want of improved regulations or defective discipline	27
Want of telegraphic communication, or of system for securing intervals of space between trains	43
Mistakes or negligence of employees	88
Excessive speed with reference to conditions of road or rolling stock	2
Foggy weather	17
Improper interference by persons not under control of the companies	2

Of the 308 contributing causes specified in this analysis, 228 were common to it with the analysis of the Commissioners. It seemed, therefore, not unsafe to conclude that the above included all the ascertainable causes of railroad accident, and that any system which adapted and vigilantly used all the appliances best calculated to prevent the occurrence of accidents, so far as they were preventible, arising from these causes, was doing all that could be required of it to secure the safety of travelers.

Acting upon these analyses and such general information as they could procure, after frequent consultations with the members of the several citizens' committees, and the committee of railroad officials appointed to advise with them, the Commissioners finally united with the latter body in making nine recommendations to the railroad corporations of the State. As will be noticed they covered only the causes of accidents numbered 6, 7, 8, 9, 13 and 14 in the analysis of the Commissioners (p. cxxix). The causes numbered 1, 2, 5 and 15 were manifestly beyond the control of legislation, or even of the railroad companies themselves, except to a limited extent. Those numbered 3, 4 and 12 were already sufficiently provided for on the statute book. There remained only those numbered 10 and 11, and these have already been made the subject of as emphatic recommendation by this Board, both to the legislature and to the corporations, as it is in its power to make (Second Annual Report, 1871, pp. 26, 27, 30). The recommendations of the Commissioners as agreed to by the committee of railroad officials were as follows:

I. A revision of the rules under which the several roads are operated.

II. The general adoption, at the earliest possible time consistent with a reasonable regard to the present condition of passenger rolling-stock, of brakes operated from the locomotive and enabling the engineer at all times to control his train.

III. The construction of all new passenger cars in such a manner as to prevent telescoping in case of accident, and the change of existing cars in this respect within a reasonable time in the regular course of repairs.

IV. The adoption of some approved standard heating apparatus, properly secured, to obviate in the greatest possible degree all danger from fire in case of accident.

V. The disuse on passenger trains of any illuminating substance other than candles or a fluid incapable of ignition at less than 300 deg. Fahrenheit.

VI. The substitution of Fresnel lanterns in place of the ordinary tail-lights now in use.

VII. The general adoption of a rule prescribing that a brakeman shall be stationed upon the last car of every train, whether freight or passenger, who shall be known as the "signal brakeman," and whose special duty it shall be to have charge of all train-signals, and to immediately provide for the safety of the rear of the train in case of danger.

VIII. The adoption of a uniform dress or cap for all employees whose duty brings them into contact with the traveling public.

IX. The general use of the telegraph in aid of the present time-table system.

In accordance with these recommendations a schedule of general rules for the operation of all the railroads of the Commonwealth was prepared by the Commissioners, approved by the committee of railroad officials after careful revision and much harmonious discussion, and will undoubtedly be very generally adopted. A copy of these regulations is printed in Appendix F of this report. A comparison of the various codes of rules now in use on the several railroads of the State made the expediency of this reform very manifest. Three corporations only, operating in all but 142 miles of road in the State, made use of the same set of rules, and in this case, though well arranged and clear, the rules were unnecessarily long, numbering no less than 220, besides some 40 additional running rules. Regulations for operating railroads should be as short and as few in number as possible, and so systematized that each employee can at a glance ascertain his own peculiar duties. In the case of these three roads the code prepared by the Commissioners reduced the number nearly one-half. Other roads again were found to be operated under a great number of rules put together without apparent system and exceedingly difficult to understand. One small road had no printed regulations, others very few; very few allusions to the telegraph, or to the duties of employees on receiving train dispatches were found in the whole collection. In very many cases the rules of the different roads guiding employees in relation to the same subject-matters were at variance. It is confidently hoped that the general adoption of the system proposed will tend, through its uniformity, to an increased acquaintance with their duties among employees, and hence to a greatly improved discipline; the public, also, will gradually become familiar with these rules and consequently with their own rights and obligations.

It is not deemed necessary to comment at any length on the propriety of each of the foregoing recommendations. The necessity of the train-brake was illustrated in the Revere collision. Could the engineer in that case, instead of whistling "brakes," have himself applied the brakes by an effort no greater than was required to give the signal, it scarcely admits of doubt that the collision would have been averted. The great advantage enjoyed by the Westinghouse and Steinard brakes over most other train-brakes which have been experimented with, is that they are in constant use and are not reserved for emergencies, when they are apt not to be in order. Neither is the use of either of these improvements at all incompatible with the application of the brake by hand should the train apparatus be out of order. The economy as regards time in making regular train-stops where this brake is in use, is also an important consideration; those who have had the greatest experience with it estimating the saving at 45 seconds to the stop. Where stations are close together, as on the roads in the vicinity of Boston, the importance of this saving in time is very obvious. The general adoption of train in place of hand-brakes may be considered a mere question of time, and the Commissioners have reason to believe that the change in this respect is now being effected upon the roads of Massachusetts with as great rapidity as can reasonably be expected.

The third recommendation was modified at the request of the committee of railroad officials, and is expressed in more general terms than was originally intended. The high opinion entertained by the Commissioners of what is known as the Miller buffer-platform, as an improvement in car construction both as regards comfort and safety, has already twice been expressed in previous reports. (Rep. 1869, pp. 90-1. Rep. 1870, p. 14.) By its general adoption alone can full effect be given as yet to the third recommendation. Objection has been made to its adoption upon certain Massachusetts roads on the ground that by bringing the cars of a train into firm contact with each other, it would not allow the play or slack necessary for starting trains on a rising grade, or in certain conditions of the track; and, also, that being a self-coupler it subjected trains to danger of parting in rounding sharp curves or in case of derailment. Upon no point in connection with rolling stock do the highest authorities differ more than upon the relative advantages and disadvantages of the self-coupling apparatus. Accidents, and very serious ones, like those at the Des Jardines Canal and at Port Jervis for instance (*ante*, p. 123), could be referred to by the Commissioners, which have arisen or been greatly aggravated, in the one case by the train having been held together, so that one part unnecessarily dragged another to destruction, and in the other case from the train having uncoupled and come apart so that disconnected cars were destroyed, simply for want of the support of the rest of the train. Any objection to the self-coupler on this score is obviated by the simple use of connecting chains. The suggested difficulty in starting trains with the buffer-platform in use is a purely practical one. Upon this point the Commissioners applied for information to Mr. C. E. Perkins, Superintendent of the Burlington & Missouri River Railroad Company, who has had great experience of the buffer-platform on a road presenting far greater difficulties of the sort referred to than any road in Massachusetts. His reply to their inquiries would seem to be fairly conclusive on the practical question involved, and will be found in Appendix G of this report. The buffer-platform, however, has great advantages over the other forms of car construction now in use in various respects, especially as regards the jerking of trains in starting or stopping, safety in passing from car to car, the use of train-brakes and resistance in case of collision. As regards all these matters, however, the Commissioners desire simply to refer to the very valuable communication addressed to them by Mr. Isaac Hinckley, President of the Philadelphia, Wilmington & Baltimore Railroad Company. The great and very generally recognized authority of Mr. Hinckley upon questions relating to railway equipment and management lends great value to his opinions, and the Commissioners have been placed under much obligation to this gentleman, who rendered them most importance assistance throughout their investigations, and by whose advice they were largely guided. The communication referred to will be found in Appendix G of this report.

The propriety of the changes and additional precautions suggested in recommendations IV. and V., seem too obvious to require comment. Recent inventions have wholly obviated any necessity for using kerosene, or any other explosive or quickly-igniting oil for the lighting of cars. All such add greatly to the horrors of the worst forms of railroad accidents, for, even if they do not themselves explode or ignite, by saturating upholstery and furniture with inflammable matter, they largely increase the danger from fire.

Recommendation VI. was especially insisted upon by the Commissioners, and was finally acceded to. The investigations made in consequence of the Revere accident disclosed the fact that collisions of trains following each other on the same line of tracks were of not infrequent occurrence, and were peculiarly liable to occur on foggy nights. In has already been stated in this report that in the case of the Revere collision the reflecting head-light of the following locomotive was distinctly seen by a passenger standing at the rear of the Beverly train, and that, in the judgment of this person, an ordinary tail-lantern, such as those with which that train was equipped, could not have been seen at the same distance.* The accidents of 21st November,

* Minutes of Proceedings. Vol. 21, p. 3.6.

* This fact is of such importance that the Commissioners take the liberty of printing the extract relating to it from the private letter addressed to them by Mr. Arthur T. Lyman, of Boston, the passenger referred to. "While standing at the rear door of the rear car of the Beverly train, on the evening of 20th August last, after leaving Chelsea and before stopping at Revere, I saw behind us the head-light of an engine, which I supposed was that of the Bangor express. *It looked dim;* but I positively saw the light. The distance I could not estimate in the darkness and fog. * * * Soon the

1853, on the Fall River road, and of 7th March, 1863, on the Camden & Amboy road, beside the Seclin collision and several of those referred to in England, seem not improbably referable to the same cause. No stronger illustration of the necessity of this simple and inexpensive precaution could, however, be furnished than was furnished at Revere.

The propriety of the changes and additional precautions suggested in the fourth and fifth recommendations seems too obvious to require comment. The eighth recommendation also was suggested by the facts disclosed in connection with the Revere disaster. The extreme disorder habitually, according to the evidence, prevailing in and about the Boston station of the Eastern Railroad was in no small degree attributable to the difficulty experienced by those using the station in recognizing the employees of the company, so as to enable them to obtain correct information as to the position and movement of trains. The same trouble notoriously exists throughout the railroad system of the Commonwealth. All travelers, and especially women and children, are continually perplexed and rendered anxious by their inability to recognize employees at sight. These are generally dressed as civilians, with the exception perhaps of some obscure badge or label. How great an inconvenience this fact occasions, and how injurious it is to good discipline is only appreciated by travelers when they pass on to some road or steamboat where another system prevails. There is, in fact, more real necessity, so far as the public convenience is concerned, that all railroad employees who are brought by their duties in contact with travelers, including conductors, depot and baggage masters, brakemen and private police, should be uniformed than that the regular police should be. The reason for such a regulation is in each case the same, but the appeals of all descriptions made by strangers to railroad employees are probably much more frequent than those made to policemen. Upon this point the Commissioners suggested an entire uniform. This would have remedied the evil. The officials of the roads, however, did not deem it necessary to go so far, and a distinctive cap and band were finally settled upon as sufficient.

It was only as regards signals and the use of the telegraph in operating their roads that the Commissioners and the committee of officials were unable to arrive at a thoroughly satisfactory understanding. The suggestions originally made in this respect by the Commissioners were as follows:

IX.—The general adoption upon all single-track roads and branches of a system of telegraphic control of trains in addition to the present time-table system.

This was returned by the committee amended so as to read—"The general use of the telegraph in aid of the present time-table system," and agreed to as amended.

X.—Wherever, upon any road, trains are intended to run within ten minutes of each other, the adoption of a system of telegraphic communication from station to station, enabling each train to be fully informed as to the condition of the track to the next station ahead. Or in lieu of a system of signals providing for intervals of *space* between following trains, a system which shall provide for a certain interval of *time* between such trains.

This was returned with the following indorsement: "Of questionable expediency. The committee deem the accompanying rules a sufficient provision for securing the object the Commissioners have in view." (See Rules 37 and 121, Appendix.)

XI.—That an acquaintance with telegraph operating shall, in future, be made one of the essential requirements in the case of all applicants for certain positions under the railroad companies, in the same way that reading and writing now are.

This was indorsed as follows:

"In view of the possible failure of the telegraph when most relied upon, the committee fear that disaster would be increased and aggravated by a dependence upon its operation in the hands of persons who would have only infrequent occasions for its use. They are also confident that the interest which the Commissioners have excited on the whole subject of safety signals will lead to better results in the adoption of such as are suited to the circumstances of the respective roads than can reasonably be expected from any iron rule applied to all."

The object of the Commissioners in making recommendations IX.–XI. was to bring the telegraph into complete use, as an auxiliary to operation throughout the railroad system of the State; to have, in fact, the telegraph a necessary and recognized part of railroad machinery, with the use of which every station-master and conductor must be familiar as a prerequisite to his holding his place. The expediency of this change, merely on the ground of economy to the corporations, was strikingly illustrated throughout the investigation which followed the Revere disaster. A very large proportion of the rolling stock of the Eastern Railroad was rendered unavailable during the week ending the 26th of August, when it was most needed, because trains were standing still at points of passing, waiting for other trains which were out of time. The track was perfectly clear for miles, but no orders were received, the road was operated in the dark, and the wheels stood still to the equal loss and inconvenience of the public and the corporation. The systematic use of the telegraph can alone enable a company to get the greatest possible amount of work out of a given quantity of rolling stock, whether freight or passenger. Again, as regards the laying down of double tracks: this is a most costly expedient to accommodate an increasing business. The necessity of it is in many cases obviated by a thorough use of the telegraph. The Commissioners are not acquainted with a single double-track road in the United States west of Buffalo. There may be such, but they have never heard of them. Roads like the Chicago, Burlington & Quincy, the Michigan Central, etc., accommodate their vast traffic on a single track simply because they make use of the telegraph, and yet experience has shown that these roads are as free from accidents as any double-track roads in Massachusetts. The Commissioners do not wish to be considered as saying anything to discourage the construction of double tracks—they are of course safer and more convenient than any single track can be—all they desire to do is to call attention to the prodigious accuracy effected by those who have learned to thoroughly utilize the telegraph. That no Massachusetts road has ever yet done this was demonstrated by the single fact already mentioned, that in the rules of very few of the roads had any provision, even of the simplest nature, been made as to the effect of telegraphic orders, or the course to be pursued by employees in charge of trains on their receipt. The use of the telegraph without such cannot but be accompanied with danger. The Commissioners, of course, do not seek to convey the idea that no use has hitherto been made of the telegraph in operating Massachusetts railroads. On the contrary, all the companies, as a matter of course, make use of it more or less, and many of them make very general use of it; but at the same time the evidence in the Revere collision and the action of the committee of officials on the ninth, tenth and eleventh recommendations of the Commissioners make it clear that it is not in all quarters used either as much or as systematically as it well might be. The deficiency is most apparent as regards the movement of trains. Many of the roads of Massachusetts at the time of the Revere accident made use of appliances more or less crude and antiquated, such as semaphore signals, dials, sand-glasses and green flags to secure intervals of time between succeeding trains. All of these, however, have served their purpose and been abandoned elsewhere under the pressure of an increasing traffic, necessitating a more rapid movement. It is in England that the system of telegraphic signals has been developed to the highest point of perfection, and some of the results attained there are very remarkable.

For several years past the utmost exertions of the English Board of Trade inspectors have been directed toward securing the general adoption on the railroads of Great Britain of what is known as the block system. The essence of this system lies in the substitution of an interval of space between following trains instead of an interval of time.* Its operation is very simple. Where a road becomes crowded by a too rapid sequence of trains, telegraph stations are established from point to point along the more busy portion of the road. The passing of a train by any given station is telegraphed back from that station to the preceding one, and no following train can pass this preceding station until the telegraph has notified such train of the fact that the intervening space is clear. In the case of the Revere accident, for instance, after the Beverly train left Chelsea, the Portland express would have been unable to pass that station until the Beverly train was signaled as having left Revere. A description of this system, as in use in England, will be found in appendix H of this report. Where it has been thoroughly adopted, the roads have been comparatively free from collisions. The Southeastern and the London, Chatham & Dover, for instance, operating 466 miles, worked throughout on a telegraph block-system, met with no train-accident in 1870; while the London & Northwestern, worked for a small portion only of its 1,477 miles on a block, had no less than thirty-four train accidents which required investigation during the same year.

No such system has as yet been introduced upon the Massachusetts roads; simply because their traffic is comparatively light, collisions are of rare occurrence and the necessities of an overwhelming business have not compelled the innovation. And yet in discussion with the Commissioners some of the experienced officials of the roads running out of Boston have not hesitated to assert that they did not think it would be possible to operate their roads on the block principle; the fact meanwhile being that more trains enter and leave the Cannon street station in London each day through the aid of the block system than enter and leave all the stations in Boston combined. It has been estimated that an average of 50,000 persons were, in 1869, daily brought into Boston and carried from it, on 385 trains, while the Southeastern Railway of London received and dispatched in 1870, on an average, 650 trains a day, between 6 a. m. and 12 p. m., carrying from 35,000 to 40,000 persons, and this too without the occurrence of a single train accident during the entire year. On one single exceptional day 1,111 trains carrying 145,000 persons are said to have entered and left this station in the space of eighteen hours. Yet under the so-called pressure of increasing business certain of the roads leading out of Boston, unable to preserve a sufficient time interval between trains, are considering the costly remedy of a third track. The Commissioners are unable to see any equivalent advantage to be derived from such an outlay. A double-track road, with good sidings, and supplemented by a thorough block and telegraph system, besides being easier to manage and less expensive, could apparently accommodate a far greater number of trains than a mere three-track road.

One only subject remains to be considered in connection with the cause of railroad accidents, and this was not discussed between the Commissioners and the committee of railroad officials, except in connection with rule 29 of the regulations. It is, however, a fact that the most distressing class of railroad accidents, as the Norwalk, the Des Jardines Canal and the New Hamburg, occurs on bridges. There is reason to believe that almost everywhere, in Europe† no less than this country, the increased weight of rolling-stock and of modern traffic subjects our railroad bridges, especially where deteriorated by age, to a strain for which they were not originally intended. The Commissioners would again renew the recommendation concerning guard rails or joists contained in their last annual report.‡ There is reason to fear that the severe lesson of the Athol disaster has not in this respect borne its full fruit. In the coming spring the Commissioners propose to give especial attention to this important matter.

It only remains to consider what legislation, if any, in addition to that now on the statute book, the investigations of the Commissioners would seem to indicate is required to secure the greater safety of the traveling public. As has already been seen, the subjects of walking on track, grade-crossings, bridge-guards, brakes on freight cars, safety-switches, and car lighting, to which causes thirty-seven per cent. of all injuries returned have been attributable, are already provided for sufficiently. Certain other fruitful causes of accident, such as getting on or off cars in motion, falling from cars in motion, crossing track in front of locomotive, leaning from train in motion, derailments generally, crushing between cars in shifting and shackling, explosions, suicides, etc., including about 50 per cent. of the whole, relate to matters obviously beyond the reach of legislation. It is difficult to see how any law could be framed to prevent their recurrence. There remain only the matters which have been discussed, and made the subject of recommendations to the companies by the Commissioners. Enactments of more or less binding force might be passed in relation to train-brakes, car construction, car heating and lighting, tail-lights, signals, use of the telegraph, joists on bridges, and the uniforming of employees. As regards some of the less material of these, such as the lighting of cars, use of more powerful tail-lights, joists on bridges, and the uniforming of employees, it would not be difficult to frame laws which might be effectually put in force. As regards other and more really important matters, such as car construction, train-brakes and car heating, legislation would be of very doubtful expediency. The general adoption of any improvement in these respects can only be the work of time, involving very considerable changes, effected only at great expense, in all the rolling stock in use. Meanwhile new and improved appliances are continually offering themselves for trial, and any legislation which should tend to exclude such from use would probably work more harm than good. Finally, the law makes the corporations responsible, both civilly and criminally, for the careful operation of their roads; it is, therefore, a question worthy of great consideration, whether, subjected as they are to this responsibility, they should be compelled by statute, on these important points, to adopt appliances in regard to the safety and efficiency of which they may entertain grave doubts. This last consideration applies with peculiar force to any legislation looking to a compulsory use of the most important of all the improvements suggested, the telegraph and the system of block signals. In England the subject has been much more discussed than in this country, and the opinion of those most competent to judge, including the government officials, was decidedly adverse to legislation, and upon grounds which seem entitled to weight.* Much prominence was given, in the first place, to the question of responsibility already alluded to. The extreme injustice of the government assuming practical management, as regards essential details, and yet leaving the whole liability for disaster on the private corporations, was pointedly stated. The decisive objection, however, was found in the extreme and apparently insuperable difficulty which accompanies the framing of any legislation which shall be at once effective and yet elastic enough to meet all the conditions and requirements of a most complex system. A thorough system of block signals, for instance, would be absurdly unnecessary, if applied to all the railroads in the State, and would be calculated rather to increase than diminish the number of accidents. So, also, as regards telegraphic communication with all railroad stations. This the law could easily prescribe, but the use to be made of it in practice must still remain within the discretion of railroad officials. Its careless or unregulated use tends to increase the number of accidents, while to its enforced use, whether really complied with or not, every disaster would be attributed.

Finally, the only effect of additional legislation on the really important points which have been discussed, would be to impose additional criminal and civil liability in case of accidents the occurrence of which would obviously have been prevented by the use of certain appliances indicated in the statute. This liability would already seem to have been practically imposed on the corporations by the joint action of the committee of railroad officials and of this Board. The corporations can disregard the recommendations which have been made only at their own risk, and the occurrence of any accident clearly attributable to a disregard of those recommendations would, in presence of a jury, affect the interests of those responsible in a way not to be mistaken. The Commissioners have good reason to believe that the desired changes are now being effected with all reasonable rapidity throughout the Commonwealth. There is little danger that the lesson of the Revere disaster will be lost. Many corporations have already, within the last few months, extended the use of the telegraph, adopted improved train-brakes and signals, and taken other precautions. The extremely harmonious action of the committee of railroad officials with this Board will unquestionably lend a great stimulus to this movement, and as it is now progressing the Commissioners feel warranted in expressing a confident hope that the close of another year will find the railroad system of Massachusetts, taken as a whole, as thoroughly provided with improved appliances and as well protected against danger of accident as are the more advanced members of the systems elsewhere.

---

light came in sight again, I think rather less than three quarters of a minute before the collision. * * * In direct answer to your question, I am decidedly of the opinion that the ordinary red tail-lights could not have been seen by the engineer of the express train at the time when I saw the head-light of the express engine; or if they were perhaps absolutely *visible*, yet they were only so to such a degree as, at the distance at that time, to be practically invisible, and that no one on the engine could have been reasonably expected to see them."

* "The principle of securing intervals of space in place of time intervals between trains, which has now become generally known as the block-system, is one improvement on which much has of late been said, and the extension of which the inspecting officers have had occasion constantly, and too much in vain, to recommend during many years. But it is not of itself a panacea for the prevention of railway collisions, nor is it even, as I shall have to show, the principal remedy required. It becomes valuable only where it is applied under good regulations, with suitable apparatus, in the hands of trustworthy servants, and with the aid of good discipline, especially as regards signal-men and engine-drivers. It requires also to be introduced, employed and properly maintained in combination with sufficient accommodations—sidings and independent sidings or relief lines for marshaling, shunting and generally disposing of goods trains out of the way of passenger traffic, with carefully adapted signal and point arrangements, including concentration of the levers and interlocking between them in proper signal cabins, with ample break-power in the trains, and with more stringent regulations in regard to reduction of speed, the observance of signals, and the greater use of detonating signals in foggy weather."—*Report of Capt. Tyler*, p. 3.

The above extract conveys apparently a fair idea of the excessive precautions necessary to the safe operation of English railways. In speaking of the accidents upon them it is to be borne in mind that they are called upon to accommodate a traffic absolutely unknown in America. As, for instance, where two hundred and seventy regular trains of one line alone pass a given junction each twenty-four hours, or four hundred and sixty-nine trains both ways pass a single station daily, with a regular interval of five-eighths of a mile; or where one hundred and thirty-two trains enter and leave one station during three hours of each morning, and the same number during three hours of each evening, being one train for every 82 seconds.

† "Many railway iron bridges have been in use for a great number of years, and some of them were originally constructed with a view to lighter rolling stock than that of the present day. As these deteriorate from wear and tear, and from rust, they necessarily become weaker, and it is of the utmost importance that they should, under careful supervision, be supported, strengthened or renewed, before any risk of actual failure occurs."—*Tyler*, pp., 5-6.

‡ "Did the roads make it a rule to lay down upon all bridges and approaches thereto double or guard rails inside of each rail of the track, a locomotive or car; meeting some obstruction on the rails on one side, would have its wheels on the other side held between the track and the guard rail, and would thus move only straight forward and could not diverge in such a manner as to run off the stringers. Or, it above the stringers, good sound cross-ties were placed, not more than 1½ feet apart from center to center, and extending three or four feet outside the rails to an additional stringer, with a guard timber placed midway between the rails, the engine or car on leaving the rails would be supported by the cross-ties, and would be prevented by the guard timber in the middle from diverging so far as to strike the side of the bridge. As old and used-up iron would answer every purpose of guard rails, the cost of taking this precaution would be very slight to the corporations. It would constitute a great safeguard to the traveling public, and the loss entailed by one such accident as that at Athol would probably cover the expense of laying down guard rails on every bridge of the Commonwealth."—*Second Annual Report*, pp. 26-7. See also upon this point Mr. Hinckley's letter, App. G.

* Upon this point Capt. Tyler says in his report (p. 38):—"The next question that naturally arises is, whether further interference, either by powers delegated to a government department, or by the more direct action of the legislature, is now desirable, and whether any measures of this description would tend to diminish the number of accidents on railways. * * *

"Looking to the various remedies, divided under fifteen heads, which were enumerated, it is obvious on a first glance that many of them might speedily be applied, wherever they are required, with great advantage; and that the sooner they were brought into practical operation the sooner, *pro tanto*, would the number of accidents diminish, and benefit result in respect of the comparative safety of railroad traveling. * * And there can be no doubt that for the immediate object of safety any pressure from without, by which the companies could be induced or compelled more rapidly to adopt remedies of this description, would so far be advantageous. But it must be remembered, on the other hand, that a railway requires daily and hourly supervision and repair, as regards its works, permanent way, rolling stock and other parts, as well as that many of the remedies enumerated have reference to care in design and construction of details; to maintenance, regulations and discipline; and to increase of conveniences in working, as from time to time they become required. Any interference which would tend to relieve the railway companies of such responsibility as now rests upon them would have a mischievous rather than a beneficial tendency, as would also any system of interference which led to divided control; and any attempt at interference in the actual maintenance or working of railways must lead to a division of responsibility, as well as to a division of control. It is desirable, and even unavoidable, that improvements should, on any railway which is worked as a joint-stock concern, for the profit of shareholders, be introduced by, and under the auspices of those who are intrusted with its management; and especially in cases in which success depends upon care in construction, maintenance and daily discipline. Either the government must take the management of railways into its own hands, in which case all the officers and servants of the railway companies would become officers and servants of the government, or it must leave the management to the companies. Direct interference with details of working, of management, of maintenance, or of increase from time to time of accommodation or appliances, would necessarily lead, as long as the companies are working for a profit, to constant complaint and recrimination. The shareholders would be discontented and the public dissatisfied; the officers of the companies would point to government interference, and the government officers to company management, as causes of evil; and when an accident occurred the responsibility would lie between the two, and it would be the natural endeavor of each to shift it to the other."

To the same effect the Commissioners take the liberty of printing the following forcible extract from a private letter, addressed to one of their board by a prominent official of the Board of Trade, of Great Britain:

"Any scheme for the purchase of the railroads by the government will have my warmest support when it comes. At present we are only pestered by constant demands that the government should interfere in all kinds of trivial details of management, by means of legislation, e. g.: that they should introduce a bill to compel companies to supply *foot-warmers!* My constant answer to these applications is that government is not afraid to work the railroads itself, but that it will not meddle with existing management, nor divide responsibility with it, nor endeavor to effect by legislation that which is beyond the province of legislation, namely, the settlement of administrative details."